MACKENZIE VALLEY PIPELINE INQUIRY

IN THE MATTTER OF APPLICATIONS BY EACH OF
(a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES; and
(b) FOOTHILLS PIPE LINES LTD. FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE NORTHWEST TERRITORIES,
FOR THE PURPOSE OF A PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINES

(Before the Honourable Mr. Justice Berger, Commissioner)

Yellowknife, N.W.T.
September 18th 1975

PROCEEDINGS AT INQUIRY

Volume 64

APPEARANCES:

Mr. Ian G. Scott, Q.C. Mr. Stephen T. Goudge, Mr. Alick Ryder and Mr. Ian Roland	for Mackenzie Valley Pipeline Inquiry;
Mr. Pierre Genest, Q.C. Mr. Jack Marshall, Mr. Darryl Carter, and Mr. John Steeves	for Canadian Arctic Gas Pipeline Limited;
Mr. Reginald Gibbs, Q.C. Mr. Alan Hollingworth	for Foothills Pipelines Ltd.;
Mr. Russell Anthony, Prof. Alastair Lucas	for Canadian Arctic Resources Committee;
Mr. Glen W. Bell and Mr. Gerry Sutton	for Northwest Territories Indian Brotherhood and Metis Association of the Northwest Territories;
Mr. John U. Bayly	for Inuit Tapirisat of Canada and the Committee for Original Peoples' Entitlement;
Mr. Ron Veale and Mr. Allen Lueck	for Yukon Native Brotherhood;
Mr. Carson H. Templeton	for Environment Protection Board;
Mr. David Reesor	for Northwest Territories Association of Municipalities
Mr. Murray Sigler	for Northwest Territories Chamber of Commerce

Yellowknife, N.W.T.

September 18, 1975

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Go ahead, Mr. Marshall.

D.H. HUSHION: Resumed

A.B. WETTERBERG: Resumed

E. SHELTON: Resumed

B. HOLTSBAUM: Resumed

CROSS-EXAMINATION BY MR. MARSHALL CONTINUED:

Q Mr. Wetterberg, I believe we were dealing with a paper, Fracture Initiation Propogation and Arrest which is referenced at 3b-5.5 of the Foothills application, where it is stated that the theories in this Battele paper, dated November, 1974, were used to evolve conditions for fracture control. We provided you with a copy of that paper last night and you've had a chance to look at it. Have you sir?

WITNESS WETTERBERG:

A Yes sir, I have.

Q Specifically I directed you to the last sentence on page J-30 of that paper, a statement that says "Until a consistent and satisfactory co-relation is found for these materials, that does predict full scale behaviour, it is impossible to accurately specify the toughness requirements of these materials". The question I put to you was, to ask whether or not you consider on the basis of this statement, that the Battele hypothesis is applicable to the behaviour

of the pipe that Foothills proposes to use.

A We're very familiar with this paper . I was glad of the opportunity you gave us to look at it last night and familiarize ourself with this one sentence that you had picked out to support your case. These materials that was the contention yesterday that they did not know what materials they were talking about. In fact reference new materials that Battele tested, they're the low carbon, low alloy controlled roll types of material. These materials were found to have separations and it was found that they were more pronounced in the heavier walled materials, particularly in the heavy wall materials tested by CAGPL, the 720 material. And Battele concluded from these tests that the CAGPL pipe, that their hypothesis did not predict precisely the fracture propogation behaviour of the 720 wall pipe.

Now in this report they do say that separations are a function of pipe wall thickness and that they are thickness dependent. However, the hypothesis and in fact the entire documentation that they have here is valid for non separated lighter walled materials.

Now the Foothills pipe wall material is approximately 40 percent lighter than the materials tested by Battele in these full scale tests.

Q Will the Foothills Pipe materials have separation?

A If I could just conclude here.

Q I'm sorry. I thought you had got to the end of your answer.

A And as referenced earlier, we do have some experience in 503 wall material and there has been no separation reported in that material.

Now we also appreciate from this report, and I quote another sentence in the report, it's the last paragraph, in that section, it says full scale tests conducted on these materials have given confusing results. The confusing results, according to Battele, are results that they have found it very difficult to propogate sheer fractures in high toughness material. That's even under ideal experimental conditions. It is these high toughness materials that we're specifying in our pipe, to prevent long propogating fractures.

Q As is Arctic Gas, specifying high toughness materials?

A They were I understand at one time specifying high toughness materials, that's correct.

Q I don't think there's any disagreement about the difficulty in getting a crack to propogate the material of a very high toughness. I think Arctic Gas and Foothills are on common ground on that point. It's very difficult, even under controlled test conditions to get a crack to propogate at all. There's no disagreement about that.

THE COMMISSIONER: Mr. Wetterberg, there is no disagreement about that, is that the situation?

A The last statement, there is no disagreement. They are very difficult to propogate in high toughness materials.

MR. MARSHALL:

Q Sir, just specifically on this point of separations, what about the pipe that will be used in the Foothills projects, will it have separations, or do you know?

A I can't answer that because we have not looked at all of the test data from that pipe. But as I've indicated, 503 material did not have any separations in it, and I don't know whether the 540 will have separations in it. But it is thickness dependent, so the lighter the wall, the less you're going to have of this particular problem.

MR. SCOTT: Mr. Commissioner, could I ask the witness to get just a little closer to the microphone. His voice tends to drop off a little bit, as he seems to be dealing with Mr. Marshall right underneath him.

MR. MARSHALL:

Q Well in the end result, Mr. Wetterberg do you feel that you can rely upon the Battele hypothesis to predict the fracture arrest behaviour of the Foothills pipe or do you feel that you can't rely upon it?

A We feel that that is perhaps the best available information in the industry to date to handle this particular problem.

Q Well perhaps it would be of

some interest to you sir to know that Battele have indicated to the advisors of Arctic Gas that in their opinion, there are too many unknowns and extrapolations to use the Battele hypothesis for the Foothills pipe unless there's been verification experimentally? I have correspondence I can refer you to.

A I can't comment on that, I haven't seen what they are basing that theory on or opinion on. They certainly have not experienced tests, full scale tests on any of our pipe.

THE COMMISSIONER: Why don't you produce the correspondence for --

MR. MARSHALL: I have the letter of July 28th, 1975 from Battele, signed by Mr. R.J. Iver. It's addressed to Mr. Purcell at Northern Engineering. I will provide a copy of the letter to the witness.

MR. SCOTT: Is it going to be marked as an exhibit or for identification?

THE COMMISSIONER: Well I think it should be.

MR. MARSHALL: Yes, Mr. Scott, we will have an additional copy prepared for the -- for entry as an exhibit. What number would that be? 254?

(LETTER FROM BATTELE TO N.E.S. JULY 28th,1975 Re COMMENTS ON THE FOOTHILL USAGE OF BCL FRACTURE HYPOTHESIS MARKED EXHIBIT 254)

WITNESS WETTERBERG: A Mr. Marshall, they say in this second paragraph here that again they are re-emphasizing the fact that materials, that their philosophy or hypothesis relates to materials without separation, and I just point that out to you.

MR. MARSHALL:

Q Well I think it would be

unreasonable to cross-examine the witness on the document until he has had an opportunity to review it in some detail.

THE COMMISSIONER: Well carry on with other matters then, --

MR. MARSHALL: Yes I will sir.

THE COMMISSIONER: -- and we will return to that later.

MR. MARSHALL:

Q Mr. Holtsbaum, in your evidence you address the question of the possibility of corrosion problems connected with the use of fracture arrestors. I was wondering whether or not you have conducted any studies or experiments related to this point?

WITNESS HOLTSBAUM:

A Not directly with fracture arrestors as such. They have a very limited application so there's really none available to test.

Q Well then if there have not been specific studies, would it follow that your views as to possible corrosion problems related to the use of the particular type of crack arrestor that you dealt with in your prepared evidence, are simply at this point preliminary observations?

A When you speak specifically of crack arrestors or fracture arrestors, this may be true, however what concerns me most in this regard as a corrosion engineer dealing with soil side corrosion, is that on the particular type of arrestor that

I described, where there is a band around the pipe, that maybe in electrical contact with the pipe, should corrosion occur in the annulus between the arrestor and the pipe, cathodic protection cannot control this corrosion. Cathodic protection is a means by which a corrosion engineer can attempt to control the corrosion on the pipe after it has been installed.

I would have to, maybe go back and say, that I have indicated that corrosion is significantly reduced because of the lower temperatures.

Q Yes, that's another point I want to get to you with in a moment, but sir with respect to the possible corrosion problems that you see may develop with the use of a particular type of crack arrestor that you discussed in your evidence, is it your opinion as an expert in corrosion that you would be able to develop solutions to prevent corrosion from occurring? If such an application were used?

A Are you referring to a solution that would be introduced between the crack arrestor and the pipe?

Q Do you have an answer to the problem? Basically, that's what I'm getting to. Do corrosion engineers have an answer to the type of problem that you say you foresee with the use of this --

A I think I indicated later on in the testimony that if this particular type of arrestor was used, the ideal way to prevent it would be to initially prevent any water entrance into the

annulus.

Q And this could be done by sealing off the ends of the crack arrestor?

A Yes, if you could demonstrate to me that this could be done practically and effectively.

Q This is something that you haven't studied?

A Well, no, we are not entertaining crack arrestors, so I haven't been commissioned to study this.

Q Mr. Hushion, perhaps if I could just recap briefly with you some of these points that we have been going over. On the question of the Battele hypothesis and whether or not it can be relied on to predict the fracture arrest behaviour of the Foothills' pipe, do I take it really from my discussion with you and Mr. Wetterberg that Foothills doesn't really now know whether or not it considers that the hypothesis will predict the behaviour?

WITNESS HUSHION:

A No, I believe that we feel more inclined that the hypothesis is satisfactory for our parameters and specifications.

Q Do you reject then the suggestion, that without experimental verification of the application of the hypothesis, that there is no basis for making that assumption?

A It probably would be of assistance if we were to have tests run, however, I

think until we feel that -- delve into the material that's been presented here and follow it through a little bit more in what we are seeing about what Mr. Wetterberg has mentioned as far as these pliations, these separations that are involved, whether they are that much concern to us with the wall thickness we are looking at. I think we will continue to study that, but at this time we still feel that the work that Battele has done previously has been progressive up to a point, where they got involved with the Arctic Gas specifications in all areas of the wall thickness and the grade and what-not, and there is a plateau there where it suddenly has fallen off. We think that the specifications that we have now still would adhere to the hypothesis.

Q But there's qualification in your opinion, because of the --

A Well, I don't think you ever want to be stagnant in this thing, we're continually looking to be sure that it is right at all times.

Q Well sir, that leads into the next point really, that I was interested in, that the crack arrestor tests, the three tests that have been conducted by Arctic Gas, or at the request of Arctic Gas by Battele have been to conclude that crack arrestors do stop cracks and they consider that to be sure evidence that they're going to be able to successfully stop, in the very unlikely event that any occur. Do I take it that you simply don't accept the results of those tests?

A That is correct, really, There have been tests and there are so many variables involved. as you know, in looking at them. Some of the fractures were arrested in the body of the pipe, some entered -- some were arrested, there were two, if I remember correctly that were arrested in the crack arrestors, but the pipe had varying velocities, it had varying notch toughness, in many areas. As I recall, one of the tests completely jumped over the crack arrestors, the weld went and it went to the other side of the weld. In fact the whole joint was thrown some 800 feet from the test site. I think these are enough things to cause concern and really, it seems to me a little premature to do this. On top of the tests there are some things that they haven't done, as we were trying to point out yesterday. There

are stresses that have not been checked or tested to date. There's this problem of this continuity in the pipe because of the arrestor on it and Mr. Holtsbaum has just pointed out that there needs to be some work done in corrosion and concern of this. Really what we're saying is that further work has to be done. If you put one of these arrestors on the top of spiral weld pipe have they checked the problem of this arrestor under tests onto the weld of the spiral type for example. Has this been done? What would happen under a hydrostatic test condition, when you have one of these, if I accept your four foot arrestor. That's a typical one say for example. What is the effect of the stresses under a hydrostatic test condition. This hasn't been really answered as yet. We feel that even in the hydrostatic test, if this is put on, there are what amounts to almost a joint per mile that wouldn't actually have a satisfactory yield test in the final answer. I think these are the type of things that we're objecting to, and until such time as those are proved, personally, I have great difficulty in accepting them.

Q I think there are two aspects to the matters we've been discussing. If I can attempt to simplify it a little bit, the first is as to the utility of crack arrestors. That is, do they work, and is it fair to say that there's simply a difference of professional opinion, engineer to engineer, between Foothills and the Arctic Gas organization as to the utility or effectiveness in stopping the propogation

of ductile fractures of the crack arrestors that have been tested?

Is that fair, you're proceeding from the same data base and you have one opinion, and other engineers have another opinion. That's what it gets down to.

A Well, it appears to be if you're telling me that they have this opinion.

Q The other aspect of it is, as I see it, is you say that aside from utility questions, you see that there are potential problems that may be created because of the use of crack arrestors and the first that you mentioned was, the possibility of stress problems, and it's clear is it not that that is something that has not yet been studied by Foothills? There are some tests proposed and they're getting underway but nothing has been done.

A Much of it has not been studied by anyone.

Q To your knowledge?

A To my knowledge, yes.

Q So in making that statement, in challenging the crack arrestors on that ground , Foothills does not yet have experimental data behind that opinion. It remains a question of opinion as to something that may be a problem but you don't yet have experimental results to verify that one way or the other?

A Well it seems that you have this around the other way, Mr. Marshall. What we're saying

is we can't accept the use of these things until the tests of nearly all this data and other things that haven't been thought of yet, need to be contended with.

Q Well surely Mr Hushion, there may have been work done that you're not aware of?

A I'm certain that's probably right.

Q We're dealing with what Foothills knows in making these assertions that have been made in its evidence. That's what I'm interested in. In making this assertion, that there may be stress problems, if Foothills has any experimental data, to back up that assertion or is it simply a matter of opinion as to a possible problem?

A It's a concern to us.

Q It's a concern to you. And you're going to carry out some research in that area through Dr. Glockner?

A Yes.

Q Fine, now about the possible corrosion problems that the panel has indicated may arise with the use of a particular type of crack arrestor and the witness made it clear that he wasn't sure which particular type would be selected for use . It's clear that there has been no experiments or tests conducted to determine just what the nature of that problem might be. It remains again, in the area of a concern that a corrosion engineer has in that area?

A Well we're not attempting to prove the success of crack arrestors. We concluded that

that there is a much simpler way and more satisfactory way to do this. I don't think we are intending to use crack arrestors and are pointing ourselves towards all the studies that would prove their validity.

Q Well the simpler way that you've mentioned, involves derating of your pipe from 1440 to 1250 with 15 to 20 percent loss in throughput?

A Yes, we think it's more fitting for an Arctic pipeline and we feel also that the introduction of no matter how many tests are run on crack arrestors, to introduce another dimension such as that into a unique pipeline in its own sense, with enough problems as it is, without introducing one more.

Q I see, so you see there are -- there is a concern recognized andyour approach is to take one engineering solultion and the Arctic Gas approach is to take a different one? AGain, we've got a difference in professional opinion as to which is the best route to go.

A You may put it that way, yes.

Q Just before leaving this matter of corrosion, as I understood the evidence of Mr. Holtsbaum, that while he hasn't conducted specific tests on this, there are solutions to the type of problem that he foresees, known to the corrosion protection industry. Measures can be taken to deal with the type of corrosion problems which might arise.

WITNESS HOLTSBAUM:

A ARe you directing that to

me, Mr. Marshall?

Q Mr. Hushion is the head of the panel. Is that where we end up?

WITNESS HUSHION:

A Well I don't know that Mr. Holtsbaum has solved the entire problem. He probably has some thoughts like everyone else, initial thoughts. Maybe in his further studies there may be new problems and thoughts that arise that need to be answered too. I don't think he's say he has a solution.

Q All right, in any event, on this whole point that we've been discussing and the hypothesis and the arrest of it and the use of crack arrestors and so on, we're dealing with the subject of arrest of fractures, we're not talking about their initiation. That's a separate matter really isn't it? Indeed one on which there appears to be common ground, with the likelihood of any initiation of the fracture is minimal.

A Well, as I understand it, Arctic Gas will be looking at testing a fracture and then trying to arrest it within this 300 feet that has been presented so far.

Q Well sir, on the question -- that may be your interpretation of it sir, but on the question as to whether or not it is likely that a fracture will ever initiate, I take it that from the evidence of Mr. Shelton this is something that traditionally has been something that has been caused by third party action, a contractor doing some work and running into a pipeline, that sort of thing?

A THat's correct.

Q In dealing with that whole question of the initiation of a fracture, we are not in disagreement with respect to whether or not it is a likely event or an unlikely event. Both Arctic Gas and Foothills consider it a most unlikely event for a pipeline in northern Canada?

A That is correct.

Q And sir, on this question of offshore pipe supply, I think you agreed with me, did you not, that foreign prices have fluctuated but these fluctuations have been both up and they have been down?

A Yes sir. That is fluctuation.

Q And the domestic pipe price, you are going to provide in with some data as to the fluctuations that Foothills has found in the prices quoted?

A Did we promise that, counsellor?

MR. HOLLINGWORTH: I am not sure whether we did or not. It seems to me it is something that Mr. Marshall is quite as capable as we are of getting?

THE COMMISSIONER: I thought that was the big argument about that last night.

MR. SCOTT: It wasn't promised. it was ruled on that it would be produced as I recall it, Mr. Commissioner.

MR. MARSHALL: That was my recollection as well but I thought it best to touch on it again this morning. Is that not where we stand, sir?

THE COMMISSIONER: I think so.

MR. HOLLINGWORTH: Well if that's what you thought, that's fine.

THE COMMISSIONER: I thought it was the pattern in steel prices within Canada that it was agreed it would be provided.

MR. MARSHALL: Well, specifically I had asked about the quotations for the Foothills pipe, not simply a published price list of steel by the ton that is circulated to industry by Canadian pipe mills or steel producers.

Q Then sir, we dealt with the question of the experience Alberta Gas Trunk Lines Limited has particulars about their experience with

some 40 inch pipe in some locations. I believe I understood correctly, did I not, that some of this pipe is operating under the precise conditions that would prevail or the proposed Foothills system?

A No sir, some of it is refrigerated, for example.

Q Right, and we looked at a number of things, wall thickness differences, notch toughness differences, transition temperature differences and operating pressure differences between what Alberta Gas Trunk Lines Limited is currently doing and what Foothills proposes to do?

A Yes.

WITNESS WETTERBERG:

A Mr. Marshall, I think you want to point out though, at this point in time, the materials that we are using though are very similar. And the metallurgy behind it is exactly the same as what is being proposed for the Foothills.

It's low carbon steels, and it is the low alloy types of steels and that we have got an understanding of these manufacturing parameters, how these materials are handled, how they are welded and fabricated in the field, how they may be bent how they are operated in the field.

Q That well may be, Mr. Wetterberg, but we are not talking about this pipe, I mean and operate under precisely the same conditions that are going to apply to the Foothills' pipe. Specifically there are differences, as I mentioned. There is notch toughness differences and transition temperature differences, pressure differences as well.

Mr. Hushion seems to agree with me.

A I just wanted to re-emphasize that the materials were not really that different than what you are perhaps emphasizing.

Q Well finally, Mr. Hushion, I may be able to set your mind at ease a little bit and tell you that Stelco have reconfirmed to Arctic Gas again this morning, their earlier advice they can make pipe to Arctic Gas specifications, and accordingly, sir, you can rest assured that your inability to obtain such pipe was not related to Stelco's inability to produce it.

Thank you, sir. Those are all the questions I have.

THE COMMISSIONER: I presume that the last question was --

MR. HOLLINGWORTH: That wasn't exactly a question.

MR. SCOTT: Is he going to place an order?

CROSS-EXAMINATION BY MR. BELL:

Q Mr. Hushion, when Arctic Gas had its metallurgy experts before us, they indicated that they were investigating the possibility of using an automatic welding machine. I was wondering if Foothills is also investigating that possibility?

A Yes sir, I believe I mentioned last evening that we already have experience with automatic welding, and are continually following this, that is in the development of additional types of equipment for automatic welding. I think we would say that we would very much intend to use automatic welding, where we can arrange this with the contractors at the time that we are constructing the pipeline, should we be successful.

Q I recall that I think it was Mr. Holmberg showed us a film of an automatic welding machine in operation, and the scene was on a sunny, summer day in Texas, and I was just wondering whether the difference in latitude would cause you any concern?

A Well ours was done in the fall. I don't recall the weather, I think it was quite nice which is usual in Alberta in the fall, but admittedly one of the concerns is under Arctic conditions and

quite some time back before the merger, when my company was, Gas Arctic as it was called then, we did a lot of investigations with respect to working with the Alyeska people and the University of Alaska in studies pertaining to automatic welding in Alaska, which would be under Arctic conditions.

Q Well would you then want to have any more studies done to assure you that this machine could be used in -- north of the 60th parallel, or are you satisfied that it could be used at this stage?

A Well we are very close to being satisfied. Mind you, I think you never stop looking at progress and checking things and doing as many tests, I suppose, as you can afford or you have time to investigate, but I would think that the possibilities for automatic welding are probably very good.

Q And if this machine were to be used, could you tell us what implications that would have in terms of the number of welders that would be required?

A It doesn't appear as yet, and certainly in the United States with the union involvement, the decrease in personnel is not a factor at all. It may be a chance in the personnel, technicians, for example, more easily trained technicians can be used to operate this equipment, and I think that is probably an advantage rather than a disadvantage with the particular problem of the pipeline and the --

Q You are saying then you

would have essentially the same number of people, but with different skills?

A Yes, that was our finding in our use of this 75 mile run of automatic welding.

I might say that the welds themselves were exceptionally uniform and very good. Mr. Wetterberg would attest to that.

MR. BELL: That's all that I have, thank you.

CROSS-EXAMINATION BY MR. BAYLY:

Q Mr. Hushion, if I may refer you to your prepared evidence at page 7, the last paragraph of question 13.

A 13?

Q Yes. There's a sentence that reads, "Undoubtedly the manufacturers have taken into consideration pipe requirements of others before dedicating pipe tonnage adequate to the needs of the Foothills' project". Now, that left some doubt in my mind as to whether Foothills had actually asked them or just assumed that this was the case?

A Since that's part of Mr. Wetterberg's testimony, may I allow him to answer that?

Q Yes.

WITNESS WETTERBERG:

A The manufacturers did, in fact, take that into consideration and it was part of their analysis of how much material or how many tons

of steel they would dedicate to this project, after evaluating those orders that they had on their books, those orders that they felt were perhaps coming up in the future years, and also an analysis perhaps of where the industry stood in other projects that were going on besides pipeline, that is the automotive industry as well as ship-building, and so on.

Q So it is more than an assumption on Foothills part, you've actually had confirmation from the pipe manufacturers that they are in a position to supply you without depriving their other customers in North America?

A That's correct. It's their normal business practice for the steel mills to assess this before dedicating and blocking tonnage.

Q While we're on the subject of pipe supply, you went into this with Mr. Marshall, somewhat last night, and that is you have made a policy decision to use Canadian pipe, as I understand?

A That's correct.

Q Now, you've given evidence as well that Foothills has a small section of Japanese pipe, in its system, and that Westcoast may have pipe supplied by people -- by suppliers other than Canadian pipe manufacturers. is that correct?

A Yes sir.

Q And I take it from your answers last night that you aren't able to tell us just how much pipe Westcoast uses say from Germany or Italy or some other part of the world.

A I think Westcoast has been exclusive users of Japanese pipe. I do not believe that they have any Italian pipe, or German pipe in their system, or French.

Q All right. before coming to this decision to use all Canadian pipe, did you look at pipe from other parts of the world to compare the

quality?

A As part of the Arctic Gas group, we had some very long and detailed discussions with all of the pipe manufacturers in the world.

Q So you are then aware of the various grades of pipe from other parts of the world, at least up until the point when you left the Arctic Gas group?

A Yes sir.

Q Now we had evidence from Mr. Holmberg who is one of the panelists on the Arctic Gas Metallurgy panel in which he ranked the various pipes. Would you agree with the ranking that he made of the various pipes. He seemed to put the Japanese pipe very high and the German and Italian very high and ranked those above Canadian pipe.

A I'm not sure what the --

MR. MARSHALL: May we have a reference, we would just like to check.

MR. BAYLY: No, I don't have the reference with me and I will be prepared to look in the index and get that perhaps at the coffee break if that's a concern But, it's either adjourn now and get it or find out whether Mr. -- whether this panel is prepared to comment on the grading of pipe from the various parts of the world.

THE COMMISSIONER: Do you want to adjourn now and get it?

MR. BAYLY: I'd be prepared to do that sir, but I'd also be prepared to do it at

the coffee break and continue with other matters so that we didn't interrupt the flow of things. I could do that while Mr. Scott was doing his examination for example.

THE COMMISSIONER: Okay.

MR BAYLY:

Q Now having made the policy decision to use Canadian pipe, should it turn out that one pipe from another country was significantly better than Canadian pipe, would that be something that Foothills would consider in its choice of manufacturer for this commodity?

A Well in our assessment of the mills, I don't believe that you'll find that the Canadian mills cannot produce the quality that we're looking for. Now these qualities may be produced in other countries, but we're specifically interested in Canadian pipe.

Q What if pipe from another country were significantly cheaper than a price you could get on Canadian pipe, would that be something that would influence your decision on where to get this pipe?

A I couldn't comment on that sir. That would be a corporate decision.

Q Pehaps Mr. Hushion could comment on that. He seems to be in that kind of position.

WITNESS HUSHION:

A Well it's a problem that

I really don't expect we would get. However, I would think that we would have to answer that only at the particular time. Certainly I think in the best interests of Canada, to use Canadian pipe, we're of the opinion the pipe that is produced in Canada is equivalent if not better to anyone else's in the world.

Q All right, could you answer my specific question on the price. Would you take that into consideration if you ran into a situation where pipe from some other part of the world of a similar quality or the same quality was significantly cheaper?

A No, I think we would remain with our policy that we would prefer to use Canadian pipe in our project.

Mind you, saying that we really don't expect the prices of any offshore to be less than the Canadian price. It's substantially higher at this time, without even taking into consideration the freight charges, if you will, the transportation charges in receiving offshore pipe. Plus the fact that there's always a possibility of these arrangements and that was what I was referring to when I was talking about familiarity with some of the manufacturers. Imagine what would happen to the schedule, tight as it is, if there were something to go wrong, with the logistics in the transportation of offshore pipe like that. Dealing in Canada and this is worth dollars, if you want to put it that way, in terms of the project, the delays that you might get involved, if anything were

to go amiss with your receipt of pipe from offshore people, would probably outweigh the difference should there be any, in the actual cost of the pipe.

Q Mr. Hushion, if I could turn that example around, and ask you to comment on it in this fashion. If you put all your eggs in the Canadian basket and you run into a strike, in the steel or pipemilling industry, are you not in the same sort of position or perhaps a worse position than if you'd spread your orders around the world.

A Well I think there's one thing, is that it's much simpler to be in contact and this is the type of thing that goes on, when you place an order with a pipemill. You remain very close to them. And I think the distance, the language barrier, things like this, customs, problems of this ilk are the type that would concern you. I think these are less prevalent in dealing directly in Canada.

Q All right. You do appreciate that there could be that kind of problem though, should there be some sort of labour dispute in the steel or pipe industry, if you are buying all from Canadian suppliers?

A Well there's always the potential of problems I must admit, yes.

Mr. Wetterberg points out that we haven't missed a construction date yet.

Q Well I'm glad to hear that.

THE COMMISSIONER: You mean

AGTL?

A Yes sir.

MR. BAYLY:

Q Now --

A I think our customer, our prime customer, Trans Canada Pipelines would attest to that.

Q If I could refer you to page 18, on the subject of atmospheric corrosion control. Question 44. Now I gather that you will in a similar way to Actic Gas, face the situation where pipe will be stock piled for a period of time prior to construction?

A Yes sir.

Q And during that period. you may face your worst problems of atmospheric corrosion, would that be fair to say?

A May I pass this one to Mr. Holtsbaum, this is his testimony also?

Q Yes.

WITNESS HOLTSBAUM:

A This would depend where it was stockpiled and for what period of time. The atmospheric corrosion rate in the north is generally very low, with the possible exception of being near the ocean.

Q This was my concern and this was something that was brought up during the cross-examination of the Arctic Gas panel, that there may be some stockpiles in the Mackenzie Delta or close to your hookup point with the Taglu plant, which may be

influenced by sea air which may have a very corrosive effect. Are there any special steps you would take in that kind of a stockpile situation, to ensure that your stock of pipe didn't get pitted or rusted?

A The schedule of stock-piling or the time element involved would have to be investigated. Certainly if the pipe is not coated prior to shipment, probably a low grade temporary coating could be applied to the pipe to prevent corrosion for the period of time that it is stored.

Q All right.

WITNESS HUSHION:

A Mr Bayly may I add some comments in there please. I think that this is a problem that is more prevalent to Arctic Gas since it is more in line with their leg, the coastal route, say from Prudhoe Bay to the tie in point of our proposal.

Q Yes, I realize you don't face that problem unless you do cross the Delta and go over to Alaska.

A That's correct.

Q Now, as I understand one of the corrosion problems may be too that you may do a factory coating of pipe but in handling that coating may be disturbed or what I believe you call "holidays" may be created on the surface of the pipe, is that correct?

WITNESS HOLTSBAUM:

A Yes, that's correct.

Q Are you recommending that there be some sort of inspection of pipe at stockpile

sites to see if this kind of damage has happened to sections and so that repairs can be done at stockpile sites?

A No, normally this repair would be done during construction because further damage could occur from the stockpile to the construction site. Repairs would certainly be made before the pipe is installed.

Q Allright, is there a method of coating the pipe with the various anti-corrosion devices that will work in the extreme temperatures that you would anticipate facing during the construction period?

A There will likely be say, a special pre-heatment before these repairs could be made, but yes, we feel that this problem can be solved.

Q All right, now when you say this problem can be solved, I take it at this point no testing has been done to see whether it actually has been solved?

A Well I might ~~out~~ point that pipelines have been installed in extremely cold temperatures in Alberta and in western Canada.

Q But not near the sea?

A Oh you are referring to marine? I don't really see the difference there.

Q I'm thinking of the corrosion problems you may face in recoating you may have to do close to the Arctic coast.

A Well I'm trying to appreciate what you are getting at there with the --

Q Well let me give you an example.

A The cold temperature is really the concern that I have, and we have to get around this.

Q All right, now what I want you to tell me is whether or not you have done the kind of experimental work to see whether this problem can be overcome, whether you can repair any coating damage at the time of installation of the pipe which is when you say you anticipate doing it.

A There are several different

types of coating available, and the decision as to which type of coating has not been made. However, before this decision is made, this is one of the problems that have to be solved before that coating would be acceptable.

Q Well will you be doing some experiments on the various kinds of coatings under extreme temperatures, say this winter?

A Maybe I'm not very clear, there are coating materials available at the present time that can be installed in cold weather, and they can meet all your requirements.

Q But when will --

A Using procedures for cold weather.

Q Well I take it from your evidence, sir, that you don't know which coating will be the most useful, the most appropriate. Is that fair to say, at this point?

A We are still reviewing the various types of coating that are available, and there has been no decision made as to which one, if that answers your question.

Q Yes, well when will you be able to tell us?

A I'm sorry, I can't really give you a date. Some of this depends on the information that is going to be supplied by manufacturers.

Q Yes, I think --

WITNESS HUSHION:

A May I comment, Mr. Bayly,

please? I just might add that this is in a period of research, perhaps. Coatings are continually coming on the market, and we wouldn't make the final decision until we are right up-to-date with the latest, but I might add that just very recently Alberta Gas Trunk Lines has bought sufficient coating to run a three mile test on some of the work that is being carried out this late fall or perhaps early winter, as a means to stay abreast of the latest developments.

Q So we will know sometime during or after this winter how those tests went, I take it?

A Yes, that is correct.

Q All right. Perhaps, Mr. Commissioner, Foothills will supply us with that information when these experiments have been carried out.

My concern, Mr. Hushion, is that by coating in the field you may be using certain substances that we would want to know about, in case if they escape or spill, may have some detrimental effect to the environment.

A Absolutely, sir, and so would we.

MR. BAYLY: Mr. Commissioner, with the exception of the question which is based on the reference to Mr. Holmberg's testimony, those are all the questions that I have. I haven't checked with Mr. Scott, but I saw his eyebrows raise when I said I would go and get that question while he was doing his examination. I hope he doesn't mind if I ask it at

some point after he is finished.

CROSS-EXAMINATION BY MR. SCOTT:

Q Mr. Hushion, I was, I guess interested in the debate about fracture arrestors. Let me see if I understand. Is it your position, leaving aside the arrestors for the moment, is it your position that the Arctic Gas Pipeline proposed is more susceptible to fractures than yours?

A Yes sir, I believe that is correct, because the outcome of one of those fracture tests and the hypothesis, is the fact that they require a much higher notch toughness, I believe in the order of 120 foot pounds, something like that, which is beyond the capabilities of the present market in pipe.

Q So leaving aside your observation that your pipeline is pretty good, leaving aside your comments about your own pipeline as being superior, I take it it is your judgment that their pipeline is more susceptible to fractures?

A Well if we accept the theory that there is a problem of ductile fracture, then the only way to contend with it is to put it into the body of the pipe, and from the tests run and the calculations, and this is the reason that Arctic Gas has reverted to crack arrestors, in essence because of the high notch toughness requirements they don't have any alternative.

Q The thing that concerned

me is that there was a lot of discussion about whether crack arrestors would arrest cracks, and then last night the thing was sort of summed up by everybody saying well there weren't going to be any fractures anyway, and it began to see to me like a matter for the theologians, rather than for the engineers.

What concerns me is this, leaving aside your own pipe for the moment, have you any information that the Arctic Gas Pipeline is susceptible to fractures at any perceptible level of risk?

A Our conclusion is it is perhaps not more susceptible, but the point is -- we say we don't expect any fractures, but in the event that one should happen, what it is now is a method of arresting the propagation of this fracture.

Q Well is there any suggestion in the information you have, that their pipeline is more susceptible than yours to fractures?

A Well it would appear so if they don't have sufficient notch toughness in the body of the pipe.

Q I take it then your conclusion that Arctic Gas is more susceptible to fractures, is based on two matters, that in your judgment they don't have sufficient notch toughness and secondly, the fact that they have gone to crack arrestors?

A That is correct.

Q Well now, Mr. Holtsbaum, on the subject of corrosion, have you read the evidence of the Arctic Gas metallurgy panel as it relates to

corrosion?

WITNESS HOLTSBAUM:

A I have read the cross-examination evidence some time ago, yes sir.

Q Yes, and have you read their transcription of their evidence in chief on that subject?

A I'm not sure I am familiar with what you are referring to?

Q Well have you read the -- I forget the Arctic Gas expert who gave evidence on the subject of corrosion, but have you read what he said at this Inquiry?

A I believe so.

Q Yes, and are there any differences in approach or methodology between what they propose to do to protect their line from corrosion, and from what you propose to do?

A None that is apparent, sir.

Q Well now I would just like to ask you in that eventuality then, a number of questions I forgot to ask of the Arctic Gas panel.

First of all, is it -- dealing with cathodic protection, is it your intention to utilize that device along the entire length of the pipeline?

A The application of cathodic protection?

Q Yes?

A Yes, sir.

Q And what is the type of anode that will be utilized?

A The anodes in an impressed current system will be a relatively inert material, most likely a high silken iron anode, possibly a graphite anode. If we use sacrificial anodes, then it will be most likely a magnesium anode, but sacrificial anodes would only support the impressed current system.

Q And what is their interval along the pipeline?

A Is their interval of rectifier sites?

Q Yes?

A I don't believe they stated that.

Q Well what is yours then?

A Well we have stated that there will be a rectifier at every compressor station site on the, say, feeder lines, there will have to be intermediate -- it will be sites, of course, because we cannot span say from Yellowknife down to the main pipeline.

Q At what intervals will those sites occur?

A The compressor stations, I believe were stated to be an average of 48 miles apart, and the intervals along the Yellowknife line would probably be in that order, possibly less, depending upon the terrain.

Q What is the current and power required for a mile of pipeline?

A There is no definitive answer to that question, it's strictly dependent on the effectiveness of the coating. We usually put in sufficient -- in this case, we will have to put in sufficient capacity in the assumption of the coating will be not as effective as we would expect it to be.

The power consumption is relatively low. We are talking in terms of oh, if you give me a moment I will try to come up with the power figure.

Q May I ask you this and it may provide enough of an answer for me, is your current going to be determined on an experimental basis?

A The first section of pipe that goes in, we will have to come up with a predicted figure, and then based on the evidence of the first section of pipe that goes in, we will then be able to come up with a closer design for the remainder of the pipe.

To answer your question on the power consumption, the power consumption would probably be the equivalent of a room full of light bulbs.

Q For the entire line?

A No, for each site.

Q Yes. Well now, are there any soil --

THE COMMISSIONER: Excuse me. A room full of light bulbs? Covering the ceiling or

filling up the room?

A Well, let's say you have a hundred watt light bulb, in terms of Ohm's law -- I won't get that technical. Say, 10 hundred watt bulbs is a thousand watts, which could be equivalent to the power consumption of one rectifier. There is quite a range, it could be much less than that, it could be a hundred watts or it could go more than that.

MR. SCOTT:

Q I take it that what is required will be determined by the first section of pipe and some monitoring or measuring to determine whether that level is effective or not?

A Yes.

Q Well now, are you aware of any soil conditions, which would make it impossible to maintain a flow of electric current and thereby lead to a break down in the system?

A The flow of current is inversely proportion to the resistivity determinant of the soil. The current will flow everywhere in that proportion or in that inverse proportion. The case which you might be getting at is there may be pockets of low resistivity soil which are trapped in rock or higher resisitivity soils. In this case, there is sometimes difficulty in getting current in sufficient quantities, if the coating is poor, to these areas.

In this case, this would apply primarily to the warm pipeline, since the cold pipeline would have frozen soil but in that case we may have to deal with these areas separately ensuring there is excellent coating in these areas and considering the use of sacrificial anodes.

Q So I take it that there are conditions which may interrupt the flow of the current?

A Not interrupt the flow sir. Once the current gets into the ground, presumably it flows everywhere.

Q Well there are conditions that will prevent the current from neutralizing the corrosion at particular places, if soil conditions meet a certain type.

A Well just specifically
what I have just said, yes.

Q Is that the effect of
what you just said, that that may occur from place to
place?

A Well no I'm saying that
this is a factor which we have to consider and design
and we'll have to overcome this particular problem.
What we do in that case is actually you might say,
impress the current in these areas directly but the
situation, I guess won't exist once the pipeline is
considered completely protected.

Q Well, in view of your
promise to use this technique on the entire line, I
notice that you haven't mentioned anything about the
effect of permanently frozen ground or frost bulbs
around the pipe. What are the anticipated effects
there?

A Well, as far as
protecting the pipeline, the frost bulbs actually
assists us. It lowers the rate of corrosion and it
lowers the current required to prevent corrosion.

Q I understand that it's
your general view, as it is that of Arctic Gas that
in permanently frozen ground, corrosion is not likely
to be as great a problem as it is in other ground. Now
I understand that, but apart from that, is there any
problem associated with maintaining an adequate flow
of current in frozen ground or in a frost bulb.
Is there any problem whatever with that?

A Well the problem is getting the current into the ground in the first place. For this reason we have indicated that we will endeavour to place our anodes in frost free soil wherever practical.

Q Well, as you're aware, a very large section of this pipeline will be in soil that is not frost free and which is permanently frozen. Would it be fair to say that the ability of cathodic protection to work in that kind of terrain is at the moment problematic. It may be that it can be resolved, but at the moment it's problematic.

A No, I don't think it' is fair to say that.

Q Well what is the situation. Is there any problem with that whatever?

A As I say, the problem is getting the current into the ground in the first place. It's been demonstrated that it can be done, in that event, the power requirements will be slightly higher, in that we have to -- well it would take more power to put the current into the ground.

Q Are you aware of any instances where this technique has been used over large stretches of permanently frozen ground and tested?

A You're referring to cathodic protection?

Q Yes.

A Not in permanently frozen ground and not in large stretches I should say.

We certainly have had a great deal of experience in protecting pipeline in high resistivity soils which, in essence, a permantly frozen ground is. Say, for example, in the mountain terrains.

Q Well is it not conceivable that in connection with frozen ground over long stretches, there may be problems that have never been approached before in terms of cathodic protection?

A Well certainly the problem in testing distance survival for example, in -- however, just in the application of cathodic protection the draining of current, we will have to -- once that current gets into the ground, it has to come back to that pipeline and we can test as we go along the pipeline to ensure that current is coming on in adequate quantities. The theory then of cathodic protection applies.

Q Well would it come down to this then, that in stretches of permanently frozen ground, there is no theoretical reason, of which you're aware, that it should not work effectively. but there is no experience from which to judge.

A There is no experience on a long line in permanently frozen ground. There has been tests of course, in permafrost. There has been tests -- of course many lines have been in soils that are frozen but to answer your question, specifically. I would have to say no.

Q Well, in the answer to your last question, you say that the pipe will be protected by complete cathodic protection. Now, as an

expression of confidence I have no quarrel with that. But wouldn't you agree with me that as a question of experience, that statement is slightly overdrawn? I say in fairness to you that you begin the sentence by saying that we are confident but I put it to you that that is an expression of the will of competent engineers to overcome problems rather than a statement of what one knows from experience. Wouldn't that be fair?

A Well certainly I'm basing that answer on an experience with pipelines under a great many environments, and I do feel confident that we can place this pipeline under complete cathodic protection.

Q But not your experience or indeed the experience of nobody, includes the kind of terrain that there is from Fort Good Hope to Taglu?

A Not to my knowledge.

Q Well now, Mr. Hushion, as I understand the evidence you have given, on the subject of these competing pipes, you have laid great emphasis on the lower operating pressure of your particular line?

WITNESS HUSHION:

A Yes sir.

Q And you have emphasized I think to Mr. Marshall that lower operating pressure by itself is not significant but what is significant is the hoop stress?.

A Well that's one of the factors, that goes along with the reduced pressure.

Q Yes, but hoop stress is a function not merely of reduced pressure, but also of thickness of the pipe and a number of other factors?

A Diameters and grade.

Q And so the significant thing surely about your pipeline upon which you rely is that you will not be operating at the permissible 80 percent of test but rather at the 69 percent of test.

A Yes.

Q And I take it that you do that -- well tell me why you operate at 69 rather than at the test of 80?

A Well we think that in the environment that we're operating at, and in an Arctic pipeline, in view of the fact that there is permafrost and it is low temperature, zero degrees in our pipeline, plus the fact that with the notch toughness that we can obtain, which is the highest obtainable in Canada, that will assist in the arrest of a fracture, we believe these are the things that have caused us to reduce our operating pressure.

Q So you have reduced your pressure and are operating at 69 percent out of a kind of prudence and a conservative nature?

A Absolutely.

Q But I take it that there is no doubt that you will submit to the test which is required at 80 percent?

A Well since the pipeline in essence is capable of operating at 1440 pounds it

would be unwise for us, during the test period, not to test it to its fullest.

Q Yes. And I take it it will be tested?

A Yes.

Q It was indicated by Mr. Lazerte on a previous panel that you might in fact subsequently use it at 80 percent, if supply and demand for gas warranted it.

A It isn't in our plans as of now. There is no need for that to happen, but what we are saying, that if in the event that, down the road, in the future, there was an increase of volume over and above what the line is capable of carrying at 1,250 pounds, which is about 2.4 million per day, then we would consider, and it depends on the time element. This is 5 years, 10 years down the road, what our operating experience would be. We would then give consideration to the fact that should we add loop or compression, or should we investigate whether it would be safe in our minds and prudent to ask for some increment, increase in pressure.

Q Yes, once the test has been completed and met, you're entitled by law to utilize it at 80 percent?

A That is correct, in Canada, yes.

Q And I take it that you have not and will not make a commitment that you will not use it at 80 percent?

A In the future or in the initial stages?

Q In the future.

A Well we would have to receive a permit to do so anyway.

Q All right, but I put it to you that when and if you utilize it at 80 percent, for which it will be tested, your pipe will, in terms of hoop strength, be no more nor less conservative than Arctic Gas', in terms of hoop strength.

A If that were to happen at that time, depending on what increment we went from 69 to 80.

Q And I put it to you that it's no accident that the 69 percent utilization is in fact entirely consistent with your judgment of present demand in the south and present supply?

A Well there is a correlation there, yes.

Q So at the moment the situation is this: Leaving aside crack arrestors, you have no need to use a pipeline at more than 69 percent?

A That is right, now. If the ultimate volume is 2.4, but really this is a build-up period. What we are saying, this is dependent on the market requirements of Canada, what it would actually would operate at. It would be much less even in the initial stages.

Q But if the market situation changes for the better, from your point of view, and the supply changes for the better from your point of view, there is nothing that will prevent you from going to 80 percent, and you may indeed do so?

A Well what we are saying is that we would be prepared to do that. Mind you, we

should add that the testing of the pipeline to yield, to be able to function at 80 percent, is something we would do no matter what pressure we intended to do it.

Q I understand that.

A This is proving the integrity of the pipeline.

Q Yes but what I am saying to you first of all, is that the 69 percent figure can be justified by Foothills on two grounds; first of all, caution and prudence, and second, your assessment of supply and demand?

A Well in operating at 69 percent and 1,250 pounds, it achieves a throughput of 2.4 billion.

Q Well the answer to my question is yes.

A When we reach that then we have things to do. Either we add compression or loop, if those additional volumes materialize.

Q Yes, and you will be entitled to and will give consideration to adding compression so that you reach 80 percent in that eventuality?

A Well what we have said is that we would have prepared ourselves for that eventuality.

Q All right.

A Whether we are entitled to would be a consideration of the permit that we receive . I would imagine that our permit would be for

1,250 pounds, so that we would have to re-apply at that stage, and if that isn't acceptable to the regulatory authorities, then we would have to do the normal thing of adding compression or loop.

Q Well now, Mr. Marshall has asked you about a number of characteristics of your pipe. I just want to see if I understand one additional one. I understand that the pipe installed by you, the 42 inch pipe, the one mile of it, was made by IPSCO, is that correct?

A I'm informed it was Stelco.

Q I see. How about the other 42 inch pipe?

A It was received from both manufacturers, both Stelco and IPSCO.

Q Yes, and have you any -- I think you have told us that a part of that pipe at least was made, according to the method or from coiled scalp?

A Yes, that is the method of manufacture that IPSCO uses in its spiral weld mill.

Q Yes, and that's like a spiral, isn't it, rather than a series of plates?

A Yes it is, it is plate or coil that's put into a spiral.

Q Yes, but that method is distinguished from the plate method?

A Well it isn't any longer since that's what the new Stelco mill -- the Stelform

mill uses plate.

Q Have you any 42 inch pipe that is made by Stelco from plate at present?

A Well we have some in transit between the mill, some 5 miles, and the order that is presently --

Q Well what I meant is in the ground?

A No sir, not as yet.

Q Have you any 42 inch pipe from plate made by IPSCO in the ground?

A Well not actually. IPSCO presently owns the mill in Calgary which has made 42 inch pipe from plate --

Q So would it be --

A -- at that time it was just another --

Q So would it be fair to say that the 42 inch pipe you have in the ground is all coiled scalp from either IPSCO or Stelco?

A Well why not put it another way and add the Big Inch Mill and then we would say that there has been 42 inch made from plate.

Q And you have it in the ground?

A Yes, sir.

Q Where is that?

A Well it's in various parts of the Alberta Gas Trunk system.

Q And who's it made by?

A Well it was made by what was known as the Big Inch Pipe Mill and this has been taken over by IPSCO.

Q Well would it be correct to say then that what you have is you have some 42 inch plate, made by IPSCO, but none made by Stelco in the ground?

A No, Stelco makes plate and it supplies the Camrose mill from which we have also bought 42 inch pipe.

THE COMMISSIONER: We will adjourn for coffee now.

MR. SCOTT: Thank you, sir.

(PROCEEDINGS ADJOURNED)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. SCOTT:

Q Mr. Hushion and Mr. Wetterberg, perhaps I could deal with the question I was vainly trying to get clear before the break. I ask you to refer to paragraph 16 of your evidence -- it's actually Mr. Wetterberg's evidence.

The question is, "you have stated the project pipe will be similar to conventional 42 inch pipe already in the AGTL operating system. To what extent do you have actual operating experience with a pipe of this type." And then the first sentence of your answer -- "AGTL has successfully installed and has operated without incident, approximately 250 miles of 42 inch grade 70 line pipe similar to the pipe being proposed for this line." Now I am instructed that the pipe installed and referred to in that paragraph, was manufactured by IPSCO from coiled scalp, is that correct?

A Some of it was from coiled scalp some of it was from the long seam U and O mill of Camrose which uses a plate product, so there are two kinds of materials making up the 42 inch grade 70, spiral weld and long seam weld -- from coil and from plate product.

Q And made both with respect to that 250 miles by either Ipsco or Stelco?

A That's correct.

Q Is it possible that processing differences have very substantial metallurgical

implications between the plants?

A I think it relates more to the type of steels and the steel chemistry to its response, As we have mentioned yesterday, that the steel chemistry responds in the plate or the scalp form and from then on, there are little properties put into the pipe in the forming of the plate product or coil product.

Q I'm not trying to suggest that the Ipsco product is either better or worse than the Stelco product, but I am suggesting to you that it is difficult at this stage to reliably predict the performance of pipe from one mill based on knowledge of the performance of pipe from another mill, would you agree with that?

A No, that's what we're saying, is that using these kinds of steels, the low carbon, low sulphur, steels, their response is known to us through this previous experience that we have had. Whether it is in the spiral form, or whether it is in the plate long seam form, is of only minor significance.

Q Well then it would come down to this, that you express confidence in your predictions, whether your experience is based with Ipsco and coiled scalp or whether it is based on Stelco and plate?

A My confidence is in the past performance of these mills and the mills discussions or discussions with the mills in which they have related

to us that they feel confident in producing these products as well.

Q Let me put it more directly, do you have any difficulty predicting the performance of Stelco if it were based on actual production from Ipsco?

MR. HOLLINGSWORTH: Do you mean as a general rule or with respect to one kind of pipe?

MR. SCOTT: With respect to this particular project.

A I guess I would have to ask you if that was the spiral product we're talking about or whether we're talking about a long seam product.

Q Well, as a general principle, I take it that you would agree with me that you don't judge the ability of Stelco to perform by reference to the fact that another company, has produced the pipe that you will be asking Stelco to produce?

A In part, but I think that what you're asking me is on the basis of the performance that Ipsco has gone through, do I feel confident that they can make this material and have they demonstrated to us that they perhaps can make it, and to that, I say yes.

Q All right.

A And to the Stelco, we have purchased 42 inch grade 70 of the low carbon material from Stelco in certainly a lighter wall thickness

but they have now demonstrated that extrapolating their expertise in that area, that they have been able to successfully make in the 540 as well. In other words, they said that they would be able to do it, we believed that they could do it and they have in fact done it.

Q Well let me ask you this. Is that installed?

A It is not installed yet, but the metallurgical responses that we predicted on the basis of previous orders of lighter wall, has come true on this heavier wall material, the 540.

Q Well one more general question, the thing that impresses me with the transcription of your evidence here is the confidence and the assurance with which you put your position. But I take it to be absolutely candid, that both CAGPL and Foothills are concerned about the metallurgical performance of their large diameter/high pressure pipes operating in low temperatures?

A Concerned in what regard?

Q Well you're sufficiently concerned to be looking carefully at the fracture problem or the fracture termination problem even though you reject the solution of another pipeline company, you're sufficiently concerned to look at that carefully.

A Yes sir.

Q And you're sufficiently concerned to be hesitant about using your pipe at 1440?

A That's correct.

Q Yes, so if CAGPL is concerned about the performance of its proposed pipe, you equally are concerned about the performance of yours.

A That's fair to say, yes.

Q And it would be correct to say, we'll leave CAGPL aside for the moment, but it's true of them too no doubt, but it's correct to say that no Canadian pipeline company has actual experience as yet, with the kind of pipe, with the defined specified kind of pipe that Foothills intends to use?

As a matter of fact, that's true, isn't it?

A With all of the combined parameters that we're putting into the Foothills pipe, your statement is correct, but if you talk about some of the parameters that we already have had and received, then your statement is not correct.

Q Well let me ask you this. You agree with me first that in terms of all the parameters as you put it, you have no and indeed nobody, has any precise experience with the pipe that you intend to use?

A That's correct we have never built a line up here before.

Q Doesn't it come down to this, that that is true of you and it is obviously true of CAGPL and what you're saying to us is our jump into the unknown is shorter than theirs.

A Very much shorter.

Q All right.

A And indeed, until delivery

is achieved, to date there has been no actual production of the Foothills pipe that has been installed?

A That's correct.

MR. SCOTT: That's all the questions I have, thank you gentlemen.

MR. MARSHALL: Mr. Commissioner, there was one matter that was dealt with by Mr. Scott that to my mind at least created some confusion. I was wondering whether I might be able to pursue that briefly with Mr. Hushion.

MR. HOLLINGSWORTH: Mr. Marshall has already been coaching Mr. Scott, since the coffee break Mr. Commissioner and then he's asking for another kick at this panel.

MR. SCOTT: I am grateful to both of my learned friends for the assistance they have given me in preperation of these matters

MR. MARSHALL: Well sir, it's a point I think is left unclear. I understood the answer had been one thing and I think, as I interpreted it --

THE COMMISSIONER: Well, I'd like you to go ahead. I can't see any harm being done.

MR. MARSHALL: Thank you.

CROSS-EXAMINATION BY MR. MARSHALL CONTINUED:

Q Well, Mr. Hushion, it had to do with the -- about the first question I think Mr. Scott was putting to you, relating to the comparative security or safety of the Foothills and Arctic Gas pipes and it just wasn't clear to me whether both you and

Mr. Scott were of one mind or whether you were talking about initiation of a fracture as compared with the arrest of a fracture. That's what I wanted to get into with you sir. As I interpreted your remarks, you were really dealing with the ability of the respective pipes to arrest a fracture.

WITNESS HUSHION:

A Yes, that is correct.

Q And you weren't talking about whether or not a fracture was likely to be initiated?

A No, I don't think either one of us has a problem with initiation.

Q Yes.

A This is the type of thing which is notably third party.

Q And on that point, your evidence had been that you were basically in agreement with Mr. Hurd's evidence that the likelihood of a fracture ever initiating was very remote.

A Very remote.

Q And that's because of the very thick pipe that either project proposed to use and the very tough nature of that pipe?

A I think just the inherent qualities in the pipe for either project.

Q And there has been evidence put in on the metallurgical panel that was called by Arctic Gas that with their pipe, with respect to the initiation of a fracture, the critical defect size is something over 6 inches, and I understand that this is something that applies both with respect to the Foothills' pipe and the Arctic Gas pipe. That is, you have to have a through wall defect in either of these pipes that exceeds six inches in length before you have a large enough defect that it's ever possible for propagation to take place from that point on?

A That is correct, five and a half to six inches.

Q Right, and unless you have something over that size, you're simply going to have a leak, not a rupture?

A That is correct.

MR. MARSHALL: Thank you sir, that's all I wanted to get into.

THE COMMISSIONER: Any re-examination, Mr. Hollingworth?

MR. HOLLINGWORTH: No sir.

THE COMMISSIONER: Well thank you members of the panel and --

MR. BAYLY: Mr. Commissioner, I wonder whether I might just ask one question. The one question I have --

THE COMMISSIONER: First of all, you have to tell us who is coaching you at the coffee break.

Or is that a matter of privilege?

MR. BAYLY: I think actually it was Mr. Marshall's secretary who helped me find the reference in the transcript.

Sir, the reference that I have is to Volume 30 of the transcript of April 15th, 1975, and for the information of Mr. Hollingworth, it's from the cross-examination of Mr. Gibbs of the metallurgy panel of Arctic Gas. It starts at page 3817.

CROSS-EXAMINATION BY MR. BAYLY, CONTINUED:

Q And the question, and I call it a question rather loosely because it goes from that page to page 3824 --

THE COMMISSIONER: It was one of Mr. Gibbs' longer questions, is that --

MR. BAYLY: Well it's not just that, sir, but there was some dispute about whether the report that he was reading from should be marked as an exhibit or not, and that is why I believe it took such a long time.

Q But in that report he invited Mr. Holmberg and Mr. Purcell to agree with him that a certain ranking of pipe manufacturers for the purpose of providing pipe of the quality that Arctic Gas wanted was the way Mr. Holmberg would rank them, and if I can just go through this question, as well as I can without reading the whole thing. As I say, it

takes up several pages of argument, which is probably unnecessary for this panel. Starting at 3817, number 1 was Mannesman Nippon Steel, and Sumitono were all judged equally capable of presenting supplying controlled rolled line pipe meeting our specifications.

Number 2, second one says Italsider and that's Italian, I take it was the question of Mr. Gibbs which the answer was "Yes, sir". They were judged fourth best in capability according to the report that Mr. Gibbs had.

Then the report went on to say, and this was the rest of the question put to the panel that N.K.K., a Japanese firm was judged least capable of the firms in the first group of producing the pipe, and the answer, which is also rather fragmented, of Mr. Holmberg basically says to the question as it continues at page 3823, "Now Mr. Holmberg, would you agree that today that sort of rating order would still put Mannesman Nippon Steel and Sumitono equally and probably best capable of supplying the pipe to meet the specifications"?

"A They are still all capable, I don't know as I would necessarily rate them exactly in the same order".

THE COMMISSIONER: Wasn't that a memorandum prepared by the Metallurgical Committee of the Arctic Gas Consortium that rated all of those international suppliers --

MR. BAYLY: Yes, sir.

THE COMMISSIONER: -- and that

was marked as an exhibit, wasn't it?

MR. HOLLINGWORTH: It is Exhibit 107, sir, I have it here.

MR. BAYLY : Yes sir, and that -- during this discussion or this questioning, there was some discussion as to whether it should be marked as an exhibit, and I would like to ask this panel whether they are familiar with that rating, and whether they would agree with it?

WITNESS SHELTON:

A Perhaps I could comment on that question. We are familiar with that ranking, or rating, and it was developed specifically for the Canadian Arctic Gas proposed pipe, that is 48 inch .720 wall thickness grade 70 pipe. IT was specifically for that type of pipe.

Q All right, would your answer then be able to continue to say that in that sense, it has no application to your 42 inch pipe of a lighter wall thickness?

A That is correct.

Q And is that the reason why this panel believes that the Canadian mills are capable of producing your pipe, though not necessarily the best producers of the Arctic Gas dimension and thickness.

A That's right, sir.

MR. BAYLY: Those are all the questions I have, sir.

THE COMMISSIONER: Well, thank

you Mr. Hushion, and members of the panel, and we are very grateful to you for coming and sharing your knowledge and experience with us. You are excused from this panel. Mr. Hollingworth, if you would like to call your next panel forward. We will adjourn just for about two minutes while these gentlemen take their seats.

(WITNESSES ASIDE)

(PROCEEDINGS ADJOURNED)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. HOLLINGWORTH: We are now ready, Mr. Commissioner, to proceed with the ninth panel on Phase 1 of Foothills' evidence, the Geotechnical Considerations,

GORDON SPAFFORD, Sworn
FREDERIC B. CLARIDGE, Sworn
DONALD M. DAVISON Sworn
FRANCIS K.C. YIP Sworn
C.T. HWANG, Sworn:
EDWARD A. MIROSH, Recalled:

MR. HOLLINGWORTH: I can introduce the panel to you. Starting on my left, and I think Mr. Gibbs wrongly referred to that as the north yesterday, I think it's more like the south. Mr. Gordon

Spafford, Dr. C.T. Hwang, Dr. Francis Yip, Mr. Mirosh with whom we are all familiar by now, Mr. Fred Claridge, and at the end, Mr. Don Davison.

DIRECT EXAMINATION BY MR. HOLLINGWORTH:

Q Mr. Mirosh, I think we can safely skip the first two questions and ask you to outline the geotechnical considerations of Foothills and its consultants.

This panel has been sworn, I should add, Mr. Commissioner.

WITNESS MIROSH:

A There has been a great deal of interest in the north by both government and industry over the last decade and as a result, a great deal of written material has been prepared on the subject of the north and its environment.

When we began on this project as Foothills Pipe Lines, we were made aware of a great deal of this material through Alberta Gas Trunk Line, who had participated in the study group and earlier as a sponsor of Gas Arctic Systems. After a review of this initial material, we concluded that two important objectives had to be met on this project and that they are, number (1) that the environment must be preserved, and number (2) that the pipeline must be secure.

We found that the two objectives go hand in hand and that it would, therefore, be of great significance to Foothills to expend considerable

energy in the area of preservation of the environment as this directly related to preserving the integrity of the pipeline.

We engaged Klohn Leonoff Consultants Limited of Calgary to assist us in carrying out geotechnical studies related to the project. Klohn Leonoff in turn derived study procedures, identified the physical environment with which we would be concerned, and began defining geotechnical problems and assessing solutions to these problems. In the course of their work they undertook site specific investigations, engineering analysis, and soil testing. Mr. Davison and Mr. Claridge of that firm will describe their involvement in more detail as members of this panel.

Shortly after we began the geotechnical studies, we became aware of the significant impact of geothermal aspects of this project. We subsequently engaged the firm of EBA Engineering Consultants of Edmonton to evaluate the behaviour of permafrost both in its natural state and following thermal disturbance such as pipeline construction activities in sensitive permafrost areas would create. EBA had a geothermal model which they subsequently developed further, such that the effect of the significant geothermal parameters along the pipeline route could be studied. Geothermal studies led directly into calculations related to frost heave and thaw settlement, both problems with which we became aware would exist and which should therefore concern ourselves with. Dr. Hwang, a member of this firm of consultants, and a

member of this panel, will expand further on his work in this regard.

We also obtained the assistance of Professor Don Coulter of the Royal Military College in Kingston and were able to use his geothermal program to assist us as well.

Hydrological considerations also became a concern to us, especially at river crossings and drainage courses along the pipeline route. In order to obtain necessary information in this respect, we subsequently hired the firm of Unies Limited of Winnipeg, who were able to help us with respect to the engineering parameters related to river floods and river bed scour. Mr. Spafford of that firm and a member of this panel will further explain his involvement with us.

The interaction of these consultants was coordinated by Dr. Yip of Foothills, who is also a member of this panel.

Q Dr. Yip. you are supervisor of geothermal, geotechnical and hydrological evaluations for Foothills Pipelines Limited?

WITNESS YIP:

A Yes

Q And does the sheet attached to the prepared evidence and having your name at the top accurately describe your academic qualifications, experience and publications?

A Yes.

Q Would you read it please?

A Education, I graduated with a BSc degree in Physics and in Engineering Physics from Dalhousie University, in 1964 and 1965 respectively. Thereafter, I furthered my study in Mechanical Engineering at the University of Calgary and obtained my MSc degree in 1967 with specialization in Fluid Mechanics. Two years later I obtained a PhD degree from the same university. My major in the PhD program was Heat Transfer.

Experience, I was employed by Link Belt Company in Toronto as a designer of dryers, coolers and conveyers for four summers from 1961 to 1964. During my graduate studies, I also worked as a teaching assistant and laboratory demonstrator. After I completed my study, I worked for the Alberta Gas Trunk Line Company Limited as an engineer. I was first trained to be familiar with all aspects of pipeline construction and operation. I was then assigned to study transient flows in natural gas pipelines and to look into the problems of pipeline construction in

permafrost regions. In 1970. I was offered a challenging position as a research scientist by the Communications Research Centre in Ottawa. There I planned studies and undertook reserach in areas of thermal control techniques and in particular did much research on the subject of heat pipes used as advanced heat exchange devices for satellite applications. In addition, I provided consultation services to the Commications Technology Satellite Project in the areas of thermal design. I was also assigned to co-ordinate thermal testing of a satellite solar-power subsystem and to participate in thermal testing activities in NASA Goddard Space Flight Centre and in West Germany.

The combination of my experience in fluid mechanics of pipeline systems and heat transfer was of interest to the Alberta Gas Trunk Line Company Limited who were planning the Mackenzie Valley Gas Pipe-line Project. They employed me again in November, 1974.

Publication, Since 1967, I have authored ten technical papers, some were presented in various conferences and some were published in Canadian, American and British journals. I have also authored seven reports published by the Communications Research Centre.

Of particular interest to the gas pipeline project are the following two papers.

(1) "Prediction of Frost Formation Around a Chilled Natural Gas Pipeline" to be presented at the ASME Winter Annual Meeting Session on Heat Transfer in Arctic Regions, November 3, 1975. Houston, Texas.

(2) "Computer Simulation of the Thermal Regime of

of Continuous and Discontinuous Permafrost" paper No 8-M1-1 to be presented at the 1975 Congress, the Engineering Institute of Canada, September 30, 1975, Winnipeg, Manitoba.

Q Dr. Yip, you are responsible for the geotechnical matters and the evaluation of the effects of thermal disturbances which appear in Part 3, Section B of the Foothills Pipe Lines Application, is that correct?

A Yes.

Q Would you please state your responsibility with Foothills Pipe Lines Ltd.?

A I am responsible for geothermal, geotechnical and hydrological matters as related to the Foothills Project. My responsibility includes engaging various geothermal, geotechnical and hydrological consultants and co-ordinating their input into the project, providing liaison with various government agencies, developing solution and methodology to cope with a variety of geothechnical and water problems.

Q Exactly what do you mean by "Thermal Disturbance"?

A The natural ground tends to follow a yearly temperature cycle which reflects the seasonal change of climatic condition. The slide that I would like to show to you -- this slide shows the ground temperature variation at a location near Inuvik where permafrost is widely encountered. Please remember that these figures only serve as an illustration.

The vertical scale, the horizontal scale, on the top, shows the temperature and the vertical scale indicates the depth below the ground surface. The various curves indicate a ground temperature at the middle, at the end of each month. As you can see, the seasonal change of temperature is the greatest --

THE COMMISSIONER:
Q Excuse me, Dr Yip, I'm still orienting myself. Along the top is --

A Temperature scale.

Q And along the side is depth in feet.

A Depth in feet. Starting from zero to, when you go down to the extreme bottom, that is approximately 55 feet.

Q And those temperatures at the top represent the temperatures you find in the ground?

A Yes, these temperatures are calculated -- that's right.

MR. MARSHALL: Excuse me, I can't read the numbers on the left hand side.

THE COMMISSIONER: They are on this one but I think that must be by design. If you turn it over --

MR. MARSHALL: I didn't have a copy of that.

A These temperatures were calculated by our consultants and are typical of the permafrost region.

As you can see, the seasonal change of temperature is the greatest at the ground surface, but much less so depth of more than 60 feet. The ground at this example location, shows an annually solid layer of approximately two and a half feet. If a warm spell were encountered in any year, or the ground cover were removed or compacted, a heated foundation or road were placed on the ground, then more heat would be received at the ground surface, and furthermore the heat would be expected to penetrate deeper into the ground during the summer season. As a result, the original temperature cycle may be disturbed and a new cycle would be eventually established. This is what is referred to as a thermal disturbance.

THE COMMISSIONER:

Q Dr. Yip, I didn't mention the numbers were upside down, thinking I would betray my ignorance but now that Mr. Marshall has raised it, that's the way it's supposed to be, is it?

A Could you repeat that again?

Q Well I don't suppose it is important but it may turn out to be. On this slide and on my sheet, the numbers in the left hand column which represents the depth beneath the surface of the earth, are upside down and I thought well that's the way you people in your profession portray this kind of thing and Mr. Marshall wasn't satisfied with that so I just wondered--

A I think that's the normal procedure of the graph, yes.

THE COMMISSIONER: Go ahead, don't let me stop you.

MR. HOLLINGWORTH:

Q Dr. Yip, how do you predict the change of ground temperature as a result of thermal disturbances?

(SLIDE: TEMPERATURE VARIATION AT LOCATION NEAR INUVIK MARKED AS EXHIBIT 255)

A The applicant relies on computer simulation of the change of ground temperature for any anticipated thermal disturbance, being aware of this scarcity or site specific data. The use of the computer reflects the complexity of geometry and of the physical processes which are not amenable to a mathematical solution or formulae.

EBA Engineering Consultants Limited in conjunction with the applicant's project, has developed a workable model which, in my opinion, represents the present state of the art, and it is satisfactory tool for modelling subarctic ground temperatures and changes.

Q With the knowledge of the change of ground temerature, how would it assist you to evaluate the effects of thermal disturbance on terrain stability?

A Given a disturbance, we would simulate the change of temperature on a time basis, and from the predicted temperatures one would determine the rate and magnitude of freezing and thawing within a domain of interest. IF thawing does take place as the result of the geothermal analysis, we would be concerned with potential settlement, slope instability and buoyancy problems. On the other hand, if freezing indeed occurs, we would examine the extent of frost heave and drainage interruption.

Q Dr. Yip, would you please comment on the technique of inhibiting frost heave by increasing overburden pressure by deep burying or by

increasing berm height?

A The amount of frost heave basically consists of two components; one due to freezing of the in-situ pore water in soils and the other due to freezing of additional water drawn towards the frost bulb. However, as water is being sucked towards the freezing front by means of some type of pulling force, depletion of water content in the underlying unfrozen soils, if it is to be completely restored, may result in consolidation and settlement.

Therefore, the net heave would be the sum of the two previous components, minus the amount of settlement due to consolidation. By increasing overburden pressure by deeper burial or by increasing berm height, one can suppress the water from moving towards the freezing zone, hence inhibiting frost heave. Foothills is presently carrying out an in-depth model study of the problem by considering simultaneously the major mechanisms of frost heave, the detail of which will be presented by our consultant, Dr. Hwang. In our opinion, such a rational approach will lead to a better understanding of the frost heave, and therefore may reduce the amount of select material required and/or the depth of burial.

I think that is the end of my direct evidence.

Q Fine. Mr. Davison, are you director of Klohn Leonoff Consultants Limited, a consultant to Foothills Pipe Lines Limited?

WITNESS DAVISON:

A Yes.

Q ANd does the sheet attached to the prepared evidence and having your name at the top, accurately describe your academic qualifications and experience?

A Yes.

Q Can you read that into the record, please?

A My formal education is comprised of obtaining two degrees, a B.A.Sc. degree in civil engineering in 1958 from the University of British Columbia, and an S.M. degree in civil engineering in 1959 from the Massachusetts Institute of Technology in Cambridge, Massachusetts.

I have been obtaining experience in the geotechnical field since 1952, however my professional history commenced at graduation in 1959.

Since 1959, I have been employed by Klohn Leonoff Consultants Limited, formerly known as Ripley, Klohn and Leonoff. During the period 1959 to 1964, I was a geotechnical engineer for the construction of the Squaw Rapids Hydroelectric project, and field drilling advisor for the initial investigations of the Nelson River Hydroelectric projects in Northern Manitoba.

From 1964 to 1968, I was manager of Klohn Leonoff, Winnipeg office, responsible for all engineering carried out by the office, which included projects within the discontinuous permafrost

zone of northern Manitoba.

From 1968 to 1971, I was manager of Klohn Leonoff, Calgary office. I am now a Director of Engineering for the company, responsible for engineering carried out in the prairie provinces, and the Northwest Territories.

Since 1963, I have been involved in various permafrost engineering projects. Some of the projects relative to this panel, which I have either managed directly or acted as a review consultant for our staff are as follows:

1. Environmental impact studies, the Richards Island and Parsons Lake Gas Gathering System, N.W.T.

2. New Townsite and Townsite Expansion Studies, Gillam, Manitoba, Yellowknife, Hay River and Inuvik, N.W.T.

3. Railway Studies, a Feasibility Study for the CN-CP Arctic Railway, and Design of Cuts and Fills for a 40 Mile Railway Expansion at Thompson, Manitoba.

4. Foundation Studies, Foundation support for a heated oil storage tank at Inuvik; foundation support for a water tank at Fort McPherson; Foundation support for a powerhouse at Inuvik; Assessment of settlements for the Mackenzie Valley Hot Oil Pipeline, and Designs of dams and dykes for the Strutt Lake Hydroelectric Project, N.W.T.

Q What other areas of geotechnical engineering have you been involved in for

the Foothills' pipeline?

A We have been involved in the assessment of problems relative to, drainage and erosion, settlement, buoyancy, seismicity, slope stability, foundations for structures, access roads, and qualitative assessment of thermal disturbance and frost action.

Q And what is the status of your work relative to assessing the problems you have mentioned?

A The studies we have underway at present are related to drainage and erosion and slope stability. We feel that these are the subjects that require better definitions and tentative solutions before entering final designs. The other subjects require site specific information which we feel only can be gathered during final design.

Q What is your approach to studying these specific problems?

A Our approach has been to use experience, observations and analyses. We use experience gained from permafrost engineering projects as well as experience gained from conventional geotechnical projects. However, in using the latter, care must be taken that only relevant geotechnical experience is used, since ice is the fourth component added to the usual geotechnical components of soil, water and rock.

Several types of observations are of assistance in solving geotechnical problems.

Some forms of observation are general and may be relevant to route location, a topic discussed by Mr. Gillespie on the Location Panel. Such observations are made to avoid areas of possible slope instability and "sensitive" terrain.

Other forms of observations include gathering specific information which can then be related to the location of the pipeline or associated structures. For example, data can be gathered from an existing landslide which indicates the factors which caused the landslide. A slope design can then be made which takes these factors into account. However, the application of observed field behaviour to a particular problem requires careful observation and analysis to ensure that the observed behaviour is pertinent to the problem.

Concerning the Foothills' pipeline route for the preliminary designs, we are concentrating on gathering data on a regional basis along the proposed pipeline corridor. There are a number of theoretical analyses available to solve geotechnical problems. However, the important point is how these analyses are applied to the particular problem to be solved. Sound application of theoretical analyses requires solving actual engineering problems. In regard to the Foothills pipeline, we are gathering data along the proposed route and making preliminary designs for a variety of conditions. Only in the final phase will a design and construction manual be produced to cover the majority of engineering problems.

Q Have you differed from CAGPL in your approach to studying the problems?

A We are not totally familiar with their approach to all problems, however, I believe that our analyses and procedures are similar. The only area that I know of in which we may differ from CAGPL is in the emphasis placed on terrain typing.

Q What makes you believe there is a difference?

A Their terrain mosaic sheets show a proposed or tentative design for erosion control and drainage as well as buoyancy. By showing this information on a mosaic sheet, it suggests that they have been able to arrive at a proposed design from essentially office studies.

Q Have you used terrain typing?

A We have used terrain typing for defining problem areas and assisting our assessment of general problems.

Q How do you propose to approach problems of drainage and erosion and buoyancy?

A Mr. Claridge will give details of our approach to the problems, but we propose to study them at specific sites during the preliminary design stages of this project, to gain better definition of problems and to provide tentative solutions, during final design we propose that the design will be based on a mile by mile ground examination and selected test drilling.

Q Mr Claridge what is your association with Foothills Pipe Lines Limited?

WITNESS CLARIDGE:

A I am employed by Klohn Leonoff Consultants Ltd. which was retained by Foothills Pipelines Ltd. to provide geotechnical consulting services for the proposed pipeline.

Q And does the sheet attached to the prepared evidence and having your name at the top accurately describe your academic qualifications and experience?

A Yes it does.

Q Would you please read it into the record.

A I pursued undergraduate studies at the University of Toronto Ontario, taking studies in the Department of Applied Geology and Civil Engineering. I graduated with a BASc degree in Civil Engineering in 1965. Following that I took Post Graduate studies in Civil Engineering specializing in soil mechanics and foundations, graduated in 1968 from the University of Illinois Urbana with an MS degree.

My experience, between 1965 and 68, I was employed on power developments in British Columbia and the United Kingdom, in the investigation of landslides in Norway and in the design and operation of new equipment to measure the engineering properties of ocean sediments.

Between 1968 and 74, I was employed as Senior Soil Mechanics and Foundation Engineer with Acres Consulting Services Ltd. in Niagara Falls Ontario. I co-ordinated geotechnical studies for a hydro-eléctric station on a river in eastern Ontario. A primary concern of the project was to evaluate the effects that creation of a reservoir would have on the stability of the slopes in marine clay deposits.

Other projects in which I have participated include the design of cofferdams and slope excavations for a railway and road tunnel which crosses the Welland Canal in Ontario and studies in Brazil and Bangladesh which involved assessment of groundwater conditions and river bank stability.

I have been employed with Klohn Leonoff Consultants Ltd. since May, 1974 in the capacity of Executive Engineer. Most of the past year has been devoted to participation in northern projects, namely a hydro-electric development on the Snare River, N.W.T. and studies for Foothills Pipe Lines Ltd. My involvement with the Foothills project has included two reconnaissance inspections of the route. I have also assisted in setting up field programs for investigating slope stability and drainage and erosion features on the pipeline route. I

I am currently involved with assessing the results of field studies and implementing designs for the pipeline.

Q Please describe the nature of field data which you are obtaining in your assessment of slope stability?

A A field program was initiated during the spring of 1975 to collect data on slope conditions for the following types of slopes. Failed slopes; steep but unfailed slopes; slopes along the proposed pipeline route; slopes at preferred alternate locations; and slopes which have been disturbed for example, by fire or the clearing of seismic lines.

The program consists of field observations including the measurement of slopes, the collection of surface soil samples and the drilling of test holes. The program has been confined generally to within 5 miles of the proposed route. Thus we have been giving emphasis has been given to the specific conditions along the route as opposed to consideration of a broad region outside of the pipeline corridor.

Test hole drilling is being conducted at locations of high and steep slopes such as exist at river crossings and adjacent to slide areas where we anticipated that information concerning the behaviour of soils under study can be gained. The objective of the drilling and observational studies is to determine through field evidence the soil parameters which are applicable to each soil type and condition within a specified area. Information which is gained about slope stability will be supplemented by office

analyses and laboratory testing. Further field investigations will also be conducted during the final design stage.

Q What is gained from observing failed slopes?

A The examination of failed slopes provides evidence of the behaviour of a particular terrain under actual field conditions. By relating the conditions which pertain at the location of a landslide an assessment can be made of the behaviour of slopes across which the pipeline is to be routed. Comparisons which would be made include the following:

angle and height of slope

location of failed slope with respect to topographic and other features such as the presence of a river bend, disturbances by fire or other causes, and features of surface drainage, and

soil and ice conditions

Evidence gathered from landslides is also useful in back-calculating the soil parameters which can be used in the analysis of other slopes. Thus the parameters which may be obtained from laboratory testing can be compared with those obtained by examination and back analyses of the landslides.

A further benefit which is gained from the observation of failed slopes is a knowledge of the causes of failure. An understanding of landslide causes is useful in deciding on route locations as similar siutations, where landslides have been observed can be avoided.

Q Have you established a steepness criterion governing which slopes will be stable and those which may potentially fail?

A In theory, a criterion governing which slopes are stable and which are not would be very useful in identifying slopes which will require analysis. However, such a criterion would be an extremely regional one and it would be difficult to apply at a local scale. Local slope stability may be influenced by a wide range of factors including soil types, ice content and distribution, ground temperature and susceptibility to thermal disturbance, local drainage conditions and the presence of various erosion factors. Thus, the decision regarding which slopes should be given detailed study requires an individual assessment supplemented by the use of slope groupings and comparisons within a given locality. For this reason, no slope steepness criterion has been selected for the pipeline.

Q Can you describe a particular form or forms of landslides which you consider may have a major significance along the pipeline route?

A The most prominent and severe type of landsliding that occurs along the route is what is generally recognized as a retrogressive or retreating thaw slide. These are generally initiated by slumps which are small slides that frequently occur along the bends of river. Slumps are usually initiated by erosion and undercutting by the river. Retrogressive slides normally begin as a relatively small feature but in the presence of high ice content and where the ground

has been sufficiently disturbed by slumping and related thawing, the slide may extend further into the slope. Eventually a thaw slide can extend for hundreds of feet back from the toe of the slope.

I wish to emphasize that although slides of the type described do exist within the vicinity of the pipeline, conditions are quite variable within short distances. In every case to date. it has been possible to select a pipeline routing which avoids steep slopes and the occurrence of slides of this nature is considered to be extremely unlikely along the route selected.

Q Can the initiation of a landslide be recognized after the pipeline has been constructed and can its development be halted?

A Slides of the type which were described in the reply to your previous question follow a pattern of development which is recognizable. Major sliding is almost always the result of initial slumps which in turn are generally associated with a distinct erosion process such as occurs along the bends of streams and rivers. Erosion can be prevented through the application of granular and insulating blankets and if a condition develops where a slope is potentially unstable, treatment measures will be instituted. Notwithstanding our expressed confidence that the processes leading to the development of a major landslide can be counteracted, it is our primary intention to select a route location which avoids zones potentially high erosion and related instability.

Q Please describe the types of drainage which will affect the pipeline?

A The following categories of drainage have been described as occurring within the permafrost terrain:

well defined drainage as in streams or in gullies,

sheet flow

active layer flow

Our field studies have shown that "sheet" flow as it is known is in reality a combination of poorly defined but distinct surface drainage channels and active layer flow. We have determined that the method of treatment of defined drainage courses will apply equally well to the surface portion of the sheet flow. Further, that portion of flow occurring in the active layer has been determined to be a small proportion of the total flow occurring during runoff periods and also in respect to the total amount of drainage which is affected by the pipeline.

The types of drainage just referred to apply to the natural drainage system. With respect to the pipeline itself, two additional types of drainage may be considered. Longitudinal drainage applies where there is flow along the pipelines such as will occur along drops and slopes. In addition, cross flows will traverse the pipeline at various angles of incidence. Both types of flow create different types of problems which must be resolved in design of the pipeline mound and surrounding terrain.

Q How do you propose to control water in the vicinity of the pipeline?

A Breaks in the pipeline mound will be provided within each depression and each recognized drainage course where water flows are anticipated. As explained in the reply to your previous question, surface drainage occurs in defined channels and it is our intention to maintain flows in these channels with the minimum degree of interruption.

The principal cause of erosion is the loss of control of drainage. Therefore, in addition to providing mound breaks which will pass surface drainage effectively, full provision will be made to protect both the mound and the adjacent terrain from potential erosion following pipeline construction. The following types of protection will be instituted at the time of construction:

First, granular blankets within the disturbed zone in a drainage crossing;

Second, vegetative mats and mulches will also be used either in conjunction with or as an alternative to the use of granular protection;

Third, sand-cement sacks or a suitable alternative on the surface of the mound to protect against undercutting.

The preceding measures will be applied routinely on all drainage crossings. In addition, special protective devices will be used to control water on steep slopes crossed by the pipeline. Where the pipeline descends a slope structure such as

stilling basins at the toe of the slope and let down structures or baffles in drainage ditches will be considered. Where the slope is in fine grained ice-rich soils, granular backfill may be used to backfill the ditch trench.

Where the pipeline passes along a slope with a significant dip crossing the pipeline, additional precautions will be observed to control water which is intercepted by the pipeline mound and to ensure that it is passed without damage to adjacent drainage courses. In this regard, low diversion mounds or ditches will be installed upslope of the pipeline to serve as a diversion. In addition, safeguards will be taken to prevent buoyancy from developing through flooding of the pipeline trench. Sealants such as spray asphalt or clay bentonite will be applied on the mound and supplemented by revegetation including the use of mulch protection.

Emphases will be placed on the use of types of erosion protection which will serve both to stabilize the soil backfill and disturbed terrain adjacent to the pipeline and also to encourage the early formation of new vegetation. The applicant is also committed to undertaking safeguards which will minimize the degree of disturbance to the terrain.

Q Please describe the procedures to be followed during final design in determining the sizes and frequency of mound breaks for passing cross drainage?

A Final designs of drainage

and erosion control will be developed for the pipeline route through a combination of office studies and field examinations. Designs will be based on the following:

First, the location of both seasonal and active drainage courses as identified from aerial photographs and as confirmed and defined in detail from a walkover survey.

Second, major topographic features as determine from aerial photographs and topographic maps.

Third, local soil and ground ice conditions as identified in final probing.

Fourth, prediction of surface runoff as derived from aerial photography and topographic maps.

The detailed form of protection of drainage crossings will vary according to the erodibility of the soil, local topography, degree of cross slope, and magnitude of cross drainage, as well as other factors. Emphasis will be given in final design to the use of protection which is effective in the short term in preventing development of erosion and the use of revegetation which in the long term will be the most satisfactory safeguard against surficial deterioration.

Q From the point of view of control of drainage and erosion, can you indicate a preference for locating the pipeline around The Ebbutt Hills rather than over them?

A We have not performed

field studies which would permit a quantitative comparison of the two routes. However, because of the higher level of the Ebbutt Hills, a larger portion of the route can be expected to pass through permafrost and a higher percentage of ice rich soils can also be expected. Disturbance associated with right-of-way preparation will therefore tend to be greater for the Ebbutt route and as a greater portion of the route passes on sloping ground, attendant erosion is likely to be more severe. For this reason, we have chosen to skirt the Ebbutt Hills along relatively flat ground.

Q Mr. Spafford, what is your relationship with Foothills Pipe Lines Limited?

WITNESS SPAFFORD:

A My firm has been engaged by Foothills to advise on design criteria for specified river crossings, estimation of surface runoff, assistance with right-of-way drainage problems and analysis related to winter roads.

Q Does the sheet attached to the prepared evidence, having your name at the top, accurately describe your academic qualifications and experience?

A Yes.

Q Please read it.

A I graduated with a Bachelor of Science Degree in Civil Engineering from Queens' University in Kingston, Ontario in 1950.

After my graduation, I spent one year as a construction superintendent on

construction of highway bridges and highways.

In 1951, I joined the consulting engineering firm of H.G. Acres and Company and worked on a variety of projects in several capacities. These included assistant resident engineer for construction of a flood control dam, design engineer for a variety of hydraulic structures, preliminary designs and studies of hydroelectric and flood control works, hydrologic analysis, system power studies and project engineer for design and construction of a hydroelectric project.

In 1959 I joined the staff of the Fraser River Board as project engineer for studies of flood control and power development on the Fraser River. This assignment was completed with production of the Board's 1963 report.

In 1964 I joined the firm of Gibb, Underwood and McLellan in Winnipeg as Director of Hydraulics and Water Resource Division of that firm. In this capacity, I directed studies and design for a variety of hydroelectric, water supply and water management projects, mainly in northern Manitoba.

In 1970, two associates and I formed the consulting engineering firm of UNIES Limited, in Winnipeg where I have functioned since as Director of Engineering. Work in this capacity has included development and application of techniques quantifying hydrological characteristics of northern streams, water management studies, definition of physical processes, related to streams and shorelines, sizing and establishing design criteria for stream crossings on northern

highways, resource requirement studies and estimation of design criteria for drainage and stream crossings for the Mackenzie Valley gas pipeline.

Q What assignments relative to geotechnical evaluation has your firm carried out for the applicant, Foothills?

A We provided an assessment of stream flow characteristics for streams crossing the pipeline route with estimates of potential change in sediment load due to pipeline construction activities. The results are presented in our report, Environmental Impact Assessment, Water, Mackenzie Gas Pipeline, February, 1975.

We estimated the potential for river bed scour in the vicinity of pipeline crossings of the Mackenzie East channel and of the Mackenzie River near Naylor's Landing. The results are presented in our reports, Scour in the East Channel of the Mackenzie River Below Tununuk Point, February 1, 1975 and Scour in the Mackenzie River near Naylor's Landing, February, 1975.

We examined available information for eleven major pipeline river crossings and estimated potential for stream bed scour at each.

We provided flood runoff data in support of study of right-of-way drainage design and advised on drainage design.

Q Have you carried out any work for other agencies in connection with the Mackenzie Valley Gas Pipeline?

A   Yes. We contributed to the Environmental-Social Committee Task Force Report Number 73-28, Regional Impact of a Northern Gas Pipeline, and we carried out a variety of studies for the Environmental Protection Board (EPB) on hydrology and related physical analysis. The results of the latter work are presented in Section 7, Water, of the EPB report, Environmental Impact Assessment of the Portion of the Mackenzie Gas Pipeline from Alaska to Alberta, September, 1974.

Q   On the question of stream-bed scour, do you consider the allowances for scour indicated in your reports to the applicant to be adequate for final design of the pipeline crossings?

A   THey may not be completely adequate.

Q   Why not?

A   There is not sufficient data available for most crossings to support the analysis required for a safe final design. This will require field measurements to determine streambed materials, stream channel geometry and, in the case of the Mackenzie east channel crossing, hydrometric measurements to establish design hydraulic conditions and sediment movement. A possible exception is our study of the Mackenzie crossing near Naylor's landing where recent streambed borings have confirmed our assumptions with respect to streambed materials.

THE COMMISSIONER: Excuse me, Mr. Spafford. Where is the crossing near Naylor's

Landing?

A That's up stream of the junction with the Liard River.

THE COMMISSIONER: Okay.

MR. HOLLINGWORTH:

Q What purpose does the information you have provided on river bed scour serve?

A The purpose is to provide interim design criteria for the crossings, in support of estimates of cost, selection of method of execution, and estimate of impacts.

Q Would you say that the estimates of scour depth you have provided are conservative?

A I have tried to provide as realistic an estimate as existing knowledge will allow. However, for unknowns, the probable worst condition has been assumed so, to that extent, the estimates are conservative.

Q Did you provide river crossing information other than potential scour depth in your reports to the applicant?

A The reports include a description of the channel regime at each site and some discussion of the conditions contributing to scour. Also the extreme river discharge condition assumed in estimating potential scour is indicated. To assist in design for most of the crossings, estimated peak flood probability and water level and velocity versus discharged relationships were provided in the form of curves

showing the return period or probability that a flood of a given maximum flow will occur in a specified period of time. Two other curves indicating mid-stream depth and average flow velocity at the crossing as a function of flow were also provided.

Q Could you please describe your contribution to the design of right-of-way drainage?

A We have provided an estimate of the probability of maximum rate of flow in most of the streams crossing the pipeline and for small water courses in example analysis areas specified by Klohn Leonoff Consultants Limited.

Q Briefly, how was the probability of maximum rate of flow estimated?

A A method of computing the probability of peak runoff from the statistics of recorded climatic data was adopted. For this purpose, records of precipitation and temperature from Atmospheric Environment Service weather stations throughout the area were used. Transformation of this data to stream flow statistics requires knowledge of terrain characteristics of each cachement.

The required characteristics are obtained from measurement of factors such as cachement areas, stream channel slope, cachement transfer slope, water surface areas, stream width, terrain classification, et cetera as observed from available topographic maps, air photographs and field measurement.

Q How was the probability of maximum flow presented to right of way drainage design.

A For the sample areas studied by Klohn Leonoff the probability of occurrence for any flow crossing a unit length of pipeline was presented on a graph. The graph is for a particular location with specific land surface slope and distance from the drainage divide to the right of way.

Q Can you please explain how subsurface flow occurs in stream and river beds and what effect a pipeline would have on such flow?

A Flow through the streambed is caused by and generally varies directly as the gradient of the stream. A pipeline buried in the streambed would form a impermeable barrier to the flow in the streambed. Likewise, a frost bulb developing around a cold gas pipeline would form an even larger barrier. The quantity of flow through the streambed varies directly as the permeability of the streambed material as well as the stream gradient. Permeability may be measured by sampling of bed material and pumping tests. Where permeability is found to be relatively low, seepage rates will be low and a frost bulb will form around the pipe. As a result, seepage flows will be forced upward to the streambed. The resulting increase in stream discharge will be negligible, but there will be an increased tendency toward local scour where the subsurface flow emerges. This tendency can be approximately quantified by two dimensional flow analyses based on measured

permeability, gradient and estimated frost bulb dimensions.

The other extreme is where streambed permeability is high enough that seepage discharge can provide sufficient heat to prevent frost bulb formation. In this case, only the pipeline would form a seepage obstruction and changes in seepage velocity and direction would not be sufficient to generate scour. Some intermediate cases may be anticipated where seepage discharge could be forced to the surface of the streambed at a rate sufficient to percipitate local scour. If flow analysis indicates this possibility in a particular crossing, the problem may be solved by increasing depth of pipeline burial in the streambed.

THE COMMISSIONER: Excuse me, Mr. Hollingworth, I think we'll adjourn for lunch and come back at 2:00.

(PROCEEDINGS ADJOURNED UNTIL 2:00 P.M.)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: WHat page were we at?

MR. HOLLINGWORTH: Page 21, just commencing question 49, sir.

MR. MARSHALL: Sir, if it isn't going to inconvenience my friend, I wondered if we might deal briefly with the sitting hours for the rest of the week. We are trying to get some idea as to whether we should have people up for the O & M panel and so on.

It's your intention to sit tonight sir --

THE COMMISSIONER: Yes.

MR. MARSHALL: -- and tomorrow to what time?

THE COMMISSIONER: Well, what -- I'll leave that up to you gentlemen. What plane is it that you want to get tomorrow? I would like to sit a full day tomorrow, but we could start a little early and --

MR. SCOTT: I have made inquiries about plane arrangements for myself, and there's no way I can leave Yellowknife over the weekend, so I am prepared to sit on Friday, Friday night and Saturday.

THE COMMISSIONER: Well --

MR. HOLLINGWORTH: Strike that from the record.

THE COMMISSIONER: I'm leaving

on the 7 o'clock plane I think it is tomorrow night, so that means that there will be no Saturday sitting.

But when do you want to --

MR. MARSHALL: No, that's fine, sir. We're happy to have matters move ahead, and it's just simply a matter of whether we should be plan to be having our O & M people come up or not, and --

THE COMMISSIONER: Well let's have a sitting in the usual way from 9 to 5 tomorrow, and then start again at 1 o'clock Monday. Now, is that not suitable?

MR. HOLLINGWORTH: That's satisfactory, certainly.

MR. MARSHALL: That's fine, sir. The other point that Mr. Hollingworth had mentioned he was considering perhaps reversing the order of the last two panels, and I'm just wondering whether or not that's going to be done, because again --

MR. HOLLINGWORTH: Well I said to you, Mr. Marshall, that it's not a concern any more, so we will leave it as it is.

MR. MARSHALL: Fine, thank you very much, sir.

DIRECT EXAMINATION BY MR. HOLLINGWORTH, CONTINUED:

Q Mr. Spafford, when we closed for the lunch break, I was just about to commence question 49 which is this: Could you explain how you determine maximum water levels for pipeline buoyancy

and weighting calculation especially in swamps and flood plains?

WITNESS SPAFFORD:

A The purpose of computing maximum water levels is to determine the maximum level to which flotation of a given section of pipeline must be designed for. If the section under consideration is crossing a stream or water course, the first step in determining design water level is to estimate the probability of peak runoff. The method used is outlined in respónse to a previous question. The geometry of the watercourse, its slope and water conveyance characteristics may be estimated using maps, air photographs and field observations. This result is then used to compute the relationship between flow and water level.

Combining this information with the probability of peak runoff, will indicate the probability of occurrence of maximum water levels to assist in the selection of a design water level.

Where the pipeline crosses swamps with no defined outlet the maximum level could be defined as that swamp's approximate overflow elevation. The vegetation sequence adjacent to the swamp may also provide a guide.

Q Can you please explain how scour calculations are carried out especially with relationship to Foothills Mackenzie River pipeline crossings?

A The scour calculations carried out to date are based on very limited data in

most cases and are intended for preliminary design purposes only. The potential of scour varies greatly from one crossing to another but, in nearly all cases, the first step in its computation is to establish the extreme hydraulic condition that will generate scour, or movement, of the bed and river bank material. Tractive force exerted by a flowing stream is a function of surface water slope and water depth. In channels of reasonably uniform slope and cross section tractive force increases with river discharge, thus design for scour could, ideally, be based on the extreme flood event. Rate of scour across the channel cross section would be computed throughout the entire passage of the extreme flood wave and through an estimate of the accumulated material carried away the maximum scour depth reached computed.

For final design of the Mackenzie East Channel crossing this sort of design procedure should probably be adopted. Considerably more data than now exists will be necessary to define the extreme event which is not only a function of Mackenzie River discharge but also of differential level generated by wind on the Beaufort Sea coast. The data requirement is outlined in the report on Scour in the East Channel of the Mackenzie River Below Tununuk Point, Unies Limited, February, 1975.

In other stream crossings, it may be sufficient to start with a peak flood discharge of remote probability of occurrence, say a 1,000 year return period event, and assume that duration of this

flow will be sufficient to scour a stable channel cross section. Equations developed by T. Blench, Regime Behaviour of Canals and Rivers, T. Blench, 1957 or Guide to Bridge Hydraulics, C.R. Neill, 1973, may be used for this purpose.

In many instances it is found that an extreme flood discharge would not produce sufficient tractive force to move materials of the size and density found in the stream bed. This occurs where materials eroded during the river's degradation provided an abundant supply of materials too coarse for the river to carry. These coarse materials eventually pave the river bed and banks and arrest further erosion.

Another indicator of the extreme depth of scour is found through detailed knowledge of the soil statigraphy beneath the channel. The rivers in the area have developed their present profile over a period of some 10,000 years, and most, except in a geological time frame, may be considered to have established a stable profile. The past extreme scour occurrences are represented by the surface of native rock or overburden which underly the alluvial materials deposited by the river. In many cases, the underlying materials may be of a similar origin to the present river's alluvium and the boundary would be indistinguishable. The Mackenzie east channel may be such a case.

In others, the underlying material will be quite distinct from the alluvials and a well defined boundary can be established by exploratory drilling, trenching and in many cases shallow

seismic observations. Such exploration should extend over the entire width of the flood plain because the channel location may have changed since the most extreme scour occurred. Unless there is some reason to expect a future marked change in channel discharge control which would accelerate degradation, it may be assumed that future extreme flood events would not result in scour deeper than the lowest present level of alluvial material.

Q Dr. Hwang, are you a consultant with Foothills Pipe Lines Limited?

WITNESS HWANG:

A Yes, I am with EBA Engineering Consultants Limited, which was retained as a consultant to Foothills Pipe Line Limited in May, 1975 to participate in geothermal and frost heave studies.

Q And does the sheet attached to the prepared evidence having your name at the top, accurately describe your academic qualifications, experience and publications?

A Yes.

Q And can you read that sheet, please?

A Education, B.Sc. Civil Engineering, National Taiwan University, Taipei, Taiwan, 1962.

Master Engineering, Civil Engineering, McMaster University, Hamilton, 1966; Ph.D. Civil Engineering, same university, '69.

Experience: 12 years' experience in the field of civil engineering, including the design of earth works, bridges, retaining walls, dynamic foundation design for gas compressor stations, research in soil consolidation and deformation characteristics, thermal soil mechanics in respect to permafrost temperature regime, computer program development.

1971, a marine terminal study for the Canada Department of Public Works, to study the influence of a harbour structure on submarine permafrost.

1972 to '74, development of a geothermal model using finite element technique, for the Canadian Arctic Gas Study Limited, to facilitiate geothermal analysis of permafrost temperature regime related to pipeline construction.

Involvement in studies of heat exchange mechanisms on the ground surface in relation to meteorological data, soil moisture migration, and thermal disturbance in permafrost regime due to channel shifting.

1974 Also involved in geotechnical and thermal studies regarding mining slope stability, foundation design of oil storage tanks for the Syncrude Oil Sands development.

1974 to 75, Geothermal review on thermal pile design and other geotechnical aspects of the Alyeska Oil Pipeline Project.

Technical Publications:

1. "Finite Element Analysis of Soil Deformation";

2. "The Influence of Varying Soil Properties on Consolidation"

3. "On Solutions of Plane Strain Consolidation Problems by Finite Element Methods"

4. "Applications of the Finite Element Method to Consolidation Problems"

5. "A Thermal Analysis for Structure on Permafrost"

6. "Thermal Disturbance Due to Channel Shifting"

7. "Prediction of Frost Formation around a Chilled Natural Gas Pipeline".

8. "Pore Pressure Development upon Open Excavations"

THE COMMISSIONER: Could I ask

whether N.R. Morgenstern who was a co-author with Dr. Hwang of some of the publications he listed, that's your Dr. Morgenstern is it?

A Yes, that was the time I was at the University of Alberta.

THE COMMISSIONER: Thank you. Dr Morgenstern has been a witness here already for Arctic Gas, right?

A That's right.

MR. HOLLINGWORTH:

Q Can you describe in general terms the object of a geothermal analysis?

A The object of the analysis is to predict the changes in ground temperature that might follow a change in surface conditions during construction or by operation of a pipeline. In permafrost regions the properties and the behaviour of the soil are quite different between frozen and thawed states. Thus, the results of a thermal analysis become necessary input to the geotechnical considerations for design of river crossings, slope stability analysis, drainage and erosion control, pipe buoyancy and right-of-way behaviour. In non permafrast regions frost heavin g might occur as a result of installing a chilled pipeline depending upon soil types and availability of ground water. The results of a thermal analysis will predict the extent and the rate of a frost bulb which can be used as a part of input toward the prediction of frost heave.

Q Can you comment on the dif-

ference in technical approach between the geothermal model used by Foothills and that by CAGPL?

A Essentially they are the same one. I was involved in the development and subsequent application of the model from 1972 to 1974 for the Canadian Arctic Gas Study Ltd. when the Alberta Gas Trunk Line was a member of the consortium.

Q Can you comment on the difference in the technical approach towards frost heaving predictions between Foothils and CAGPL?

A From an engineering viewpoint, both use the same principle which is the application of overburden pressure to reduce the frost heaving rate, and therefore, the magnitude of frost heave. MUch evidence reported in the technical literature has supported such a principle. In approaching the problem, we recognize its nature to be quite different from that of thaw settlement. For the latter case, the final settlement can be determined with greater certainty. But for frost heaving, the amount of heave is an accumulative result of the heaving process as the water is being sucked toward the freezing point. Hence it is an accumulative process and more difficult to predict.

In order to realistically estimate the final frost heave over a pipeline lifetime, Foothills being aware of the semi-empirical approach reported by CAGPL, felt that there was a need to bridge the short term test data and the long term pipeline performance through an in-depth analytical modelling,

applying well-established theories of heat transfer, seepage and soil consolidations.

The following mechanisms are considered in the study:

Suction pressure at the freezing front as a function of soil properties.

(2) Variation of effective pressure applied at the frost front as a function of time. As the frost depth increases, the suction pressure at the front decreases due to the increase of soil weight above it.

(3) Freezing rate and thus the rate of heat removal in order to change the water into ice.

(4) Soil consolidation and seepage characteristics.

(5) Two dimensional seepage flow around the pipe.

MR. HOLLINGWORTH: The panel is now available for cross-examination sir.

CROSS-EXAMINATION BY MR. MARSHALL:

Q It might be helpful for the panel to have available for the cross-examination, the Neill's text that was referred to by Mr. Spafford in his report on the East Mackenzie crossing. We have a copy that we can show to him when we get to the theory that we're interested in. He has, I believe, a copy of the East Mackenzie crossing channel study? And Mr. Claridge's report on slope stability? He has that, and a copy of the alignment sheet and a copy of

the geotechnical section of the application. You have those, Mr. Mirosh?

WITNESS MIROSH:

A I think they're coming.

Q To begin with, Mr. Mirosh, perhaps you could tell us when the various geotechnical consultants were first retained by Foothills? Firstly, Booker and Associates or EBA?

A I would have to guess at this, but I would say around January or February. I'm sorry, around December of last year.

Q And Klohn Leonoff?

A About October or November of last year.

Q And Unies Limited?

A December or January somewhere in there.

Q And I think Dr. Coulter is also mentioned as one of your consultants?

A About January.

Q Of this year?

A Of this year, yes.

Q Sir, on page two of your evidence, you make reference to the EBA Geothermal Model and I believe we got into a bit of a discussion about this on one of the previous panels and you wanted to refer it to the geotechnical panel. I'll put my questions to you and when you get to the point that you want to pass them to one of the other members, feel free to do so.

Is this model based upon the model developed at, I understand. considerable cost, by Battele and Brooker between 1972 and 74 pertaining to Arctic Gas?

A I believe it is.

Q Dr. Hwang? And your answer is yes?

WITNESS HWANG:

A Yes.

Q Sir, when did you start to work on the model exclusively for Foothills?

A In May, '75.

Q I see, and in that time, sir, from May to the present, what development has there been of the model?

A The model itself essentially was not modified too much. What we do, was to improve our input data by going through recent literatures, and to improve the input data.

Q Well are there any capabilities that the model has now that it did not have at the time before you began doing this work in May?

A No, it's the same except like we are putting the moisture migration into it, but now it is not done yet.

Q Moisture migration?

A Yes,the convection of--

Q Yes, that is the model that deals with the effects of convection?

A That's right, that's being done by, but as of today it's not done.

Q I take it, sir, you would

be aware of the evidence that the Arctic Gas geotechnical panel gave on the work that was done by Battele to expand the computer model to include convection analysis as well?

A That's right.

Q So this is rather somewhat of a parallel development in the model capability, is it?

A In -- I would say in the technical sense, yes, it may be approached in different way.

Q I see. Have there been any other major modifications to the program that have been developed since May?

A In which sense?

Q Well does it have any new capabilities other than the ability now to deal with the effects of convection?

A Oh, we may -- what we do is we change, modify the meteorological region numbers, and --

Q That's just a matter of getting new data, is it?

A That's right, it's a minor modification---

Q I see, so -- okay, that's fine.

Have you other modifications that are planned to be made to the model?

A Yes, like what I just

said about moisture migration.

Q Do I take it that that hasn't been done yet?

A No. It's being done, but has not been done to date.

Q Oh I see, it's in the process of being done?

A Yes.

Q When do you expect to have that modification then done to the model?

A As soon as I get the time to do it.

Q As soon as you get off this panel?

Well, could you give me some sort of an estimate? I understand, to a lawyer at least, computers are mystifying things in the art of programming something we don't understand at all. Is there quite a bit of time required to get this modification done?

A No, not -- it is --

WITNESS YIP:

A Excuse me, I wonder if I could just add a point to what Dr. Hwang has stated.

THE COMMISSIONER: Q Certainly, sir, go ahead.

A We are planning to extend the usefullness of these computer programs. We felt that perhaps before we go that we would like to investigate the river flow, velocity, et cetera, to just determine whether there is any possibility that indeed we

need to make studies further, but we are --

MR. MARSHALL: I'm sorry, sir, I guess I kind of lean forward into the mike, I don't think you are maybe quite close enough to it because I didn't hear you too clearly.

Could I just ask you to go over that again?

A We have planned to extend the usefulness of the model, and at the same time, before we do that, we are going to estimate the possibility of icing in the river, resulting from the chilling of the gas pipeline, so we will be doing these modifications in stages, and unfortunately, due to the interruption of various types of hearings and weather, we just feel that this condition of these work will probably be delayed.

The exact date of completion is hard to tell you, is hard to give a firm answer at this stage.

Q I see. Do you think it will have been done by the end of this year, or is it something that's likely to spill over to next year?

WITNESS HWANG:

A Oh no, it won't take that long.

Q What about the aspect of icings? That will be worked in this year as well?

WITNESS YIP:

A I would have to say this will be part of the analysis.

Q I see. In due course, gentlemen, is it expected that there will be reports produced dealing with the results obtained from this newly modified computer program?

A Yes indeed, there will be reports.

Q And I take it that we'll be able to obtain a copy of those then?

A You will be the first one to get a copy.

Q Thank you very much, sir. I certainly appreciate that, I'm not generally shown such consideration.

A I always like to cooperate.

Q Mention is made in the evidence of a model developed by Dr. Coulter of Kingston. I was wondering what had led to the use of, or the introduction of another computer program or model. Could any of you gentlemen help me on that? Specifically, why when you have the work that Booker and Associates have been doing and their model, was it thought necessary to introduce Dr. Coulter's model?

WITNESS MIROSH:

A Perhaps I could make the first comment and then pass it on to Dr. Yip. Dr. Coulter is a person we have been familiar with for several years, who had worked at Alberta Gas Trunk Line at one time on similar work. His approach that he's developed over the years, takes a different mathematical approach than the one which the B ooker-Battele model

does, so we felt that taking two similar but different approaches would help us assess each model against the other.

Q And what have you found when you have done that, sir?

WITNESS YIP:

A The differences in their approach is really very minor. This is the matter of differences in the numerical methods, one is finite elements and the other one is finite difference. We, you know, the two methods -- we have done some analysis by the two methods, and we managed to obtain some general agreement because basically, well basically the approach, the mathematical formulations of the two methods are basically identical.

Q I see. I wonder if there had been reports that were produced as a result of Dr. Coulter's work for Foothills, or a comparison of his work with that of B ooker and Associates?

A Well we have some of this material together into a paper, which will be presented in the A.S.M.E. meeting. By that time you will know what was indicated -- contained in that paper.

Q I see. Sir, I notice that you had listed those papers in your curriculum vitae, but I didn't see that they were listed in the materials on which the panel was relying. Do I take it that that's just an oversight?

A No, not really. I think we would like very much to bring you up-to-date, but

the materials contained in this paper are according to the policy, I would say that unfortunately they will not be available until -- prior to the date of conference.

Q Well do I understand that you do rely on the material that's contained in these papers in support of the opinions being expressed by the geotechnical panel?

A Well we have done other types of analysis. We have quite a few analyses, geothermal analyses.

Q Well surely, Dr. Yip, you wouldn't be publishing a paper and going to Houston to present it, if it were irrelevant to your work at Foothills?

A Oh yes, they are directly relevant to our project. That's why I quote it under my curriculum vitae.

Q I wonder then if we might have copies of them, preferably as soon as we could. It seems to me, sir, that they are relevant and I suggest really they ought to have been listed among the relevant reports, and made available to us.

MR. HOLLINGWORTH: I'm not sure, but I thought I heard the witness say that they weren't compiled yet.

THE COMMISSIONER: Well no, Dr. Yip has said that one of these papers is intended to be delivered at Houston, and so on and so forth.

Well if those papers have been finished, sir, if you have completed them and they are ready for presentation, we would like to see them, even ahead of the Houston conference, if that doesn't violate the copyright or something like that.

A Well I would say this is the policy of the A.S.M.E. not to release material prior to publication.

THE COMMISSIONER: Well I wonder --

A However I am not quite sure of that.

THE COMMISSIONER: Why don't you, Mr. Scott and Mr. Hollingworth and Mr. Marshall look into this, because those papers could be very important and we don't want to interfere with anyone's rights.

MR. MARSHALL: We may all have to go to Houston to hear about it.

MR. SCOTT: Do you want us to take a few minutes to do that now?

THE COMMISSIONER: Well you can do it now or you can do it at the coffee break or tonight or -- or on the weekend. You have got time on the weekend.

MR. SCOTT: I presume that Mr. Marshall wants to see them for his cross-examination. If he doesn't, if he intends to let it go until the panel has---

MR.HOLLINGWORTH: Maybe Mr. Marshall can speak to that.

MR. MARSHALL: I think from a practical point of view, we couldn't -- even with Dr. Clark's assistance, hope to get through complicated technical reports, you know, in time to make use of them during the cross-examination, so it just seems to me though that if there is something that arises out of them, that we may be asking Mr. Hollingworth and Mr. Gibbs if they will recall the witnesses.

Q Mr. Mirosh, it was my understanding from an answer given on one of the previous panels, the station panel, I think it was number 7, that there is really no determination yet, whether or not stations are located on permafrost. I believe the way the question was answered and I haven't had a chance to check the transcript on this point. Mr. Scott I believe introduced the subject and when asked whether or not the stations would be located on permafrost the answer was set out on the basis that in certain areas, they would likely be in continuous permafrost and others in discontinuous permafrost and so on. My question really is whether or not you've got a geotechnical assessment to this point of your station sites.

A May I put that one to our geotechnical people?

Q Well do you know sir or do you not know?

A My answer would be similar to the last time.

Q Well perhaps you could give your answer then. Do you have a geotechnical assessment of your compressor station sites?

A Well I can't recall my answer last time. I hope this one is the same.

Q I am sure Mr. Hollingworth does too sir.

A Generally from Fort Good Hope North we expect continuous permafrost and those

stations located there. would be on permafrost.

Q I think we all know and have a reasonable education where the boundaries of the continuous and discontinuous zones are and so on. But have you got anything more precise than that in terms of geotechnical assessment of those compressor station sites?

A Yes, I think I was just trying to repeat my last answer and that was part of it. And then I continued that from Fort Good Hope south, there are spots of permafrost and spots of non permafrost. I believe I further said that we haven't finally located our stations. They are located on alignment sheets as we expect them to be hydrolically for the present time, but if there are changes and adjustments to be made during final field investigations. during drilling of sites and some of this drilling will no doubt indicate to us where permafrost is, then the stations will be relocated as required.

Q Do I understand correctly sir that you have indicated you've located the stations on a hydraulic basis to this point?

A That was the first step, yes.

Q Well have you gone beyond that?

A Yes, we have had field work this summer, and stations were adjusted and re-located for other parameters such as drainage, closeness to communities, this information was reflected back

to the hydraulic studies which were re-calculated.

Q Well sir, then the locations of the stations as they appear in the application materials and the alignment sheets can't be taken as being accurate, there have been some changes made as a result of work done this summer?

A No, our application still stands but we are making adjustments to the application which we will be putting forward in the future.

Q You mean there will be an amendment to reflect changes in compressor station locations?

A Yes, there certainly will be. For instance, at Fort Good Hope, we are looking at moving the line away some distance and this will necessitate recalculation and adjustment of stations.

Q Could you tell me how many stations Foothills has north of 60, is it 17?

A Seventeen compressor stations and four meter stations.

Q Do you know how many of them have had a geotechnical assessment, that is a site specific assessment to this point?

A Well we haven't drilled the stations, that would probably be the most site specific geotechnical work but we have had terrain typing and we have had certain drainage studies carried out but not at all station locations.

Q Perhaps you could give me the particulars of where you've done work and where you

haven't done work. What I'm getting at is sir, it's one thing to determine the location of compressor station sites on a hydraulic basis, we have noted on the alignment sheets that they all appear to be spaced -- they all appear to be spaced at exact numbers, down to two decimal points, which to us had indicated that you had simply selected the spacing and locations for these compressor stations on the basis of hydraulic studies. I'm suggesting to you that when you go in and take a look at them geotechnically, that may result in all sorts of changes to the location of the stations. We've had some evidence in the Arctic Gas witnesses about changes that have resulted and so on. You've indicated there's been some work done and some of the stations, you've indicated some of the subject areas. I'd like a complete breakdown really of where you stand now on the location of your compressor stations and the geotechnical assessment of those stations. Have you got that sort of information sir?

A Well we do have papers in the office which indicate the current state where we're at. This is a continuing process, as you probably know. We don't have a group of papers which together form what we will suggest will be a modified route in terms of where new station locations might be, based on this summer's field work but we do have the elements that go into that.

Q Could you tell me firstly at how many stations you have been able to carry out specific geotechnical assessments and could you identify those?

A Well we haven't been specifically carrying out site specific geotechnical investigations for the purpose of finalizing design at this stage. For that reason, we have not been on the ground carrying out drilling and other investigations of stations.

Q Do you anticipate that when you do get on the ground and make these site specific investigations of a geotechnical nature that it may result in a movement of compressor stations from where they are presently described as being located?

A This is possible.

Q Can you give me some indication as to the likely magnitude of the shift in the location of any of these stations. based on the information you have to this point?

A Well I haven't assessed personally all of the field work which is just finished during this month for us, in fact some of it is still going on, so sitting here at this time I can't do that.

Q Do you have any sort of a ballpark estimate on any of the stations at all that have been assessed to this point as to what sort of change might be required, for geotechnical reasons?

A Well I could suggest to you that we might move stations one or two miles either way and have to recalculate the hydraulics and see where the other stations lie.

Q Sir, this leads me back

into Mr.Bouckhout's evidence then, as I understood from him that Foothills now has interdisciplinary teams that are making site specific investigations, and I took it that that included compressor station sites, so that they can look at the environmental considerations and make changes or recommendations for changes in the field. I'm wondering how they 're going to do this, if you haven't yet got your site specific geotechnical investigations done and those investigations may result in changes of up to a mile or two miles. Can you help me out on this?

A Yes, I hope so. The work which Mr.Bouckhout referred to is aimed at site specific field investigations, primarily at river crossings which are the primary concern for us at this time. We feel and have felt that stations are an element -- station locations are an element that will be subject to final design analysis and although we have spotted stations, we have them on our maps. we have flown over them, in some cases people have been on the ground and probed permafrost, we do not expect to finalize these locations until we get into a final design phase.

Q Would it follow then that your site specific environmental assessments on these compressor station locations would have to wait until the final design stage?

A No, they're going on now. For instance, where we know at the present time we have stations spotted, we have carried out site specific investigations of the nature that Mr.Bouckhout

talked about and that was from the environmental and sociological aspect.

Q Dr. Yip, I see from your resume that you were the supervisor of geothermal, geotechnical and hydrological evaluations for Foothills?

WITNESS YIP:

A That's what I said.

Q And when did you join the company sir?

A I was employed by the company in November 1974.

Q You mentioned that you had had some experience with Alberta Gas Trunk Lines, as an engineer. When did that start sir. What year?

A '69.

Q 1969 you first went with them?

A Right.

Q And I note in your resume that you say "I was first trained to be familiar with all aspects of pipeline construction and operation." How long did you spend at that sir?

A Well I had a very extensive program, training program for about two months continuously.

Q Now you mention that after this intensive training program you were assigned to study transient flows in natural gas pipelines. Could you tell us something about the length of time that you spent on such studies sir and what they specifically

related to?

A I don't exactly remember the time frame, but I know that I completed one phase of the study. That study was involved with studying of the gas behaviour in a pipeline, natural gas pipeline. The dynamic behaviour, transient state, and that was completed, and was reported to the company.

Q Can you give me some sort of an estimate as to how long you would have spent on this? Would it have been a period of weeks or months or years?

A Well I would say a period of months.

Q I see. And you also mention work in looking into the province of pipeline construction in permafrost regions, and I was wondering how long you spent working on that and what the nature of the work was, sir.

A Again, I don't remember exactly the period of time I was working on that, but I was assigned at the beginning when I was with Alberta Gas Trunk Lines by Gordon Walker, the vice-president of AGTL, and look into a number of construction problems in permafrost areas.

Q Could you tell me in all the total period of time that you spent working with Alberta Gas Trunk Lines Limited, starting in 1969, what month and what month was it that you left to go to work with the government?

A I don't exactly remember the time, but it would be around May of 1970.

Q That you left to go to the government?

A That's correct.

Q And you started with Alberta Gas Trunk Lines when, in 1969?

A That's right.

Q During what month of 1969, sir?

A The end of 1969.

Q Like in December?

A I would say it was much before that.

Q I see. And then in November of last year you came to Foothills?

A THat's correct.

Q And sir, you say in your evidence, "My responsibility includes engaging various geothermal, geotechnical and hydrological consultants in coordinating their input into the project, providing liaison with various government agencies, developing solution and methodology to cope with a variety of geotechnical and water problems". This is in answer to question 8 on page 3, that describes your work load, does it sir?

A That's correct.

Q I was wondering if you could tell me from among this very heavy work load, which are the subjects that you do yourself, and which are those that are done by consultants whose work you are coordinating, because you make mention that you are developing solutions and methodology as well. So I was just interested in the breakdown. Which areas do you work in developing solutions and methodology, and which areas are handled by consultants who report to you?

A I say we have been working together. This is all coordination, sir, not entirely by myself.

Q I see.

A With the assistance of the consultants.

Q And those are the consultants represented on the panel, the firms Klohn Leonoff and Unies and EBA, as well as Dr. Coulter?

A Well we say that among this work that I have done in various areas, I think I spent more effort in the geothermal.

Q Your work's been concentrated on the geothermal yourself?

A That's correct.

Q Have you produced reports, sir, as a result of doing this work for Foothills, other than the papers that we discussed a few moments back that are to be presented this fall?

A No.

Q Were you responsible, sir, for the preparation of the geotechnical portion of the Foothills' application?

A No, it was prepared by Klohn Leonoff.

Q Were you involved in its preparation, sir?

A I was involved with that too.

Q I'm sorry?

A I was involved with that.

Q You weren't?

A I was.

Q Oh, you were? In what role sir, what responsibility did you have?

A Review of the preparations.

Q Could you tell me, sir, whether you have done any work on permafrost with Foothills, and if so, when you started your work on that?

A I don't think I got your question. Could you repeat that again?

Q When did you start doing work on permafrost?

A Well I say I started many years ago.

Q And when you were in what position, sir?

A Again I don't follow your question.

Q Well --

THE COMMISSIONER: Were you at university or were you working for some engineering company when you started?

A Oh yes, I was working for Alberta Gas Trunk Line.

MR. MARSHALL:

Q That would have been in the 1969 to '70 period?

A THat's correct.

Q That would be your first work on permafrost. What about work on frost heave? Would that have been started at the same time pretty well?

A No frost heave work began, I believe, in March, March, 1975.

Q I see. During the period of time that you were employed by the government of Canada with the Communications Research Centre in Ottawa, you wouldn't have been working on either of these two subjects, I take it?

A No.

Q Could you tell us something about the work that you have done in the field of moisture transfer in porous materials?

A Well I took courses in my graduate studies. I did work in Communications Research Centre related to moisture transfer in porous media.

Q Sir, turning to page 5 of your evidence, your answer to question 12, you discuss the effects of consolidation in limiting frost heave. Have you found the area, sir?

THE COMMISSIONER: What page is that again?

MR. MARSHALL: On page 5 of your prepared evidence.

A Again could you repeat that question, please, Mr. Marshall?

Q Well in answer to question 12 on page 5, Dr. Yip, you are dealing in part at least with the effect of consolidation in limiting frost heave. There's a reference in about the eighth line. You say in part, "If it is to be completely restored, may result in consolidation and settlement".

A Oh I think there is some typing error. This is an error here.

WITNESS HWANG:

A Could I answer that question for you?

WITNESS YIP: A Maybe Dr.Hwang can answer that question.This is not correct.

Q I haven't asked a question. I just said it's been dealt with in answer to question 12, you have raised this concept of consolidation.

WITNESS YIP:

A Dr. Hwang will probably give you some better idea than I do.

WITNESS HWANG:

A In his answer, what he mentions is this: During the moisture migration pores, the frost front, depending upon the soil compressibility below the frost/line may have consolidation mechanism happen, and therefore the resultant frost heave is first of all the heave building in-situ pore water expansion, plus the ice degradation which moves toward the frost front minus the consolidation of settlement under below which is due to the pressure change and the summation of all three are the net of frost heave.

Q I see. Now this aspect of consolidation, do I take it that's the same concept that Dr. Slusarchuk dealt with in his evidence before the inquiry, the particular reference I have is page 2334 of the transcript, and the date was March 18th of this year? Are you familiar with that?

A I cannot remember, but could you explain a little bit, then I can confirm it.

Q Well the only point was this, the concept of consolidation isn't being introduced to the Inquiry for the first time in Dr. Yip's evidence, his answer to question 12. This concept, or this principle or idea was dealt with by Dr. Slusarchuk in his evidence before the Inquiry in March. Are you aware of that or not?

WITNESS YIP:

A Can you read it? I don't think I remember exactly what he said in that evidence.

Q Perhaps at the break I can provide them with the reference and they can check it, sir, and I can move on now to something else.

Dr. Yip, we were told the other day by one of the other panels that Foothills has given some consideration to a Cross Delta route, and I was wondering whether or not there has been any geotechnical work done in connection with such a possible route?

MR. HOLLINGWORTH: Well surely, sir, that question has been dealt with before. We said that it's just been looked at. It is nothing more than a possibility and a faint possibility of that, as discussed by Mr. Blair. I don't see the point in going into it with panel after panel asking what work they have done on it, if any.

MR. MARSHALL: Well sir, if no work has been done, his answer is "no." If work has been done, then it is relevant to the Inquiry. It is

a simple straightforward proposition.

THE COMMISSIONER: Go ahead, Mr. Marshall.

MR. MARSHALL:

Q Has any geotechnical work been done, Dr. Yip, in connection with a possible Cross Delta route by Foothills?

A Can I pass this question to Mr. Mirosh, because he might be in a position to answer this question.

Q Well do you know, sir, in your position -- I understand you are in charge of all these things at Foothills -- are you aware of any work? Of a geotechnical nature that's been done in connection with a possible Cross Delta route for Foothills?

A I'm not -- I don't know if I remember if this has been mentioned or not. Maybe Ed Mirosh might --

Q Well Dr. Yip, you have only been there since last fall. Surely you know, or you remember whether or not you have done work on a possible Cross Delta route.

A Excuse me, this Cross Delta. WHat exactly where is the crossing?

Q Well we haven't been told yet, sir. All we know is that --

A Is that --

Q -- one of the witnesses in a previous panel indicated that Foothills has given

consideration to a possible Cross-Delta route, and that there has been --

A I'm sorry, I just misunderstood your question.

Q Oh, I'm sorry.

A Yes, I thought you were talking about your Cross Delta route.

Q No, I am talking about one that Foothills has apparently given some consideration to. Perhaps I should have added that Mr. Blair indicated that Foothills has at least considered whether or not it would be prepared to carry Alaskan gas if it was requested to do so by the Canadian government, and I think the answers that have followed on the introduction of that concept indicated that if Foothills were going to do that, at some later date, that they were looking at a possible route that would go via what's called the Cross Delta route.

Now, I was just wondering whether or not that the studies at Foothills had progressed to the point on this possibility that you had been asked to do any geotechnical work in connection with a possible Foothills Cross Delta route?

A I would have done some work in that area.

Q Well sir, are there any reports or studies that have been produced as a result of your having done that work?

Well again, I think Dr. Yip can answer that, whether or not he's written a report.

A You mean report on the crossing of the river?

Q Is that the work that was done by your people sir?

A That's right.

Q And what crossing would that have been sir?

A It was cross Delta.

Q Crossing of --

A Mackenzie Delta.

Q And you have studied that?

A We did.

Q Is this work that you did yourself or did others working with you or for you do it?

A It was done by consultant.

Q And who was that sir?

A I can give you -- I don't remember exactly but I think Unies has done some studies.

Q Maybe Mr. Mirosh can be of some assistance. Do you have a report from a consultant on the crossing of the delta, in connection with a possible Foothills cross Delta route?

WITNESS MIROSH:

A Well I think perhaps Dr. Yip is aware that we have discussed the cross Delta route in the office, but we have not really done a great deal of work on it and in his enthusiasm to answer you he may have not understood you correctly. But our amount of work on the cross Delta so far, has amounted basically to hydraulic studies, assuming the same route as the Canadian Arctic Gas Route, across the delta, there has been no significant work done in the environmental area. From a geotechnical point of view, I guess we've discussed such broad implications as how would one get across the delta, with one line or two lines what kind of soil is involved there, but these have been very general geotechnical discussions. The only material we really have to offer there is the hydraulics work.

Q Well Dr. Yip seemed to think that Unies had done a report. There's a representative from Unies on the panel and perhaps he can straighten us out on this.

A Fine.

Q Has Unies done some work for Foothills in connection with the possible Foothills cross Delta route?

WITNESS DAVISON:

A No sir.

Q What about Klohn Leonoff?

WITNESS CLARIDGE:

A No sir.

Q You mentioned that there was no significant environmental work Mr. Mirosh, if I

understood you correctly. Has there been any environmental work done in this connection?

WITNESS MIROSH:

A No sir, I guessed I used significant incorrectly. There has been none because the nature of our looking into the cross delta route is one of curiousity only.

Q Well I'll leave it on this point if I may Dr. Yip. If in thinking about it, later it occurs to you that someone else was involved in the preparation of a report, I'd like to hear about that through your counsel, and specifically I'm dealing with geotechnical aspects of a possible cross delta route. If you find on getting back to the office that you come across something or you remember something I want to be advised of that through your counsel please.

WITNESS YIP:

A Yes.

THE COMMISSIONER:

Q Mr. Mirosh, when Mr. Blair gave evidence he said that he expected that in years to come, he said that if Foothills built its pipeline from the Mackenzie Delta south, he expected that in years to come, gas would be found on Banks Island and Victoria Island, and that he believed that gas would then be brought out via the Foothills line. Has Foothills done any - - carried out any examination from a hydraulic engineering geotechnical pipeline design point of view, about the possiblity of bringing gas from Banks or Victoria to -- presumably to the pipeline proposed for the Mackenzie Valley?

WITNFSS MIROSH:

A Sir, I'm only aware of some general discussions that we have had regarding possible modes of transport of this gas, including a-- well not including a pipeline, I have not participated in any discussions related to a pipeline but we have thrown around other concepts of a very shall we say farout nature.

Q Well so far apparently no one has found gas on Banks Island, perhaps somebody has, but my impression was nobody had.

A As far as I'm aware.

Q Well let's just take Banks Island. When you people discussed Banks Island, you weren't considering bringing gas, if it were found, from Banks Island to the mainland by pipeline, you were considering other modes of transport, were you?

A Well, I didn't say that. I'm not aware of discussions that may have taken place related to pipelines. In fact, I'm not aware of any concrete discussions that have taken place related to any particular means but there are other ways of doing it and we have chatted about them.

Q Well. I understand that anything that was discussed was discussed in a tentative way, Mr Blair made that clear, and I understand it perfectly, but what other modes of transport were discussed in the tentative way that you have made plain they were discussed?

A Well I suppose some of the

ideas would be a tanker, if one could be obtained suitable for that environment, an airship,

Q You mean a dirigible?

A Yes sir. this is one possibility that one should not escape looking at.

Q Anything else?

A No, I think there are other ways that I've never heard anyone discuss submarines or those concepts.

Q Dr. Yip, there was one last item or that is there wasn't one last item, that part of your evidence that we had circulated to us was on page 6 wasn't read into the record, and I wondered whether that was an oversight or whether you intended to leave that out?

That would be the last part of the answer to question 12, it's carried over onto page 6?

WITNESS YIP:

A I am suprised to see a blank sheet here.

MR.HOLLINGWORTH: Do you want to put that in, is that part of your evidence?

A That:s right, there's something missing so can I read it in?

MR. HOLLINGWORTH: Would you please. Dr. Yip.

A When we are satisfied with the accuracy of the model we plan to establish a heave-profile chart along the proposed pipeline route

or some sort of manual so that the forst heave problem can be dealt with properly prior to the final design stage.

Q Mr. Davison, could you tell me your recollection of when it was that your firm started work for Foothills on this project?

WITNESS DAVISON:

A It was in the fall of '74, I don't really know the exact date. In the vicinity of October.

Q Yes, and who of your people was working for Foothills and what areas of responsibility did they have?

A Mr. Gillespie was involved in -- well our first really assignment was to review the application by Gas Arctic to see if it had applicability to the Foothills line. The individuals who were involved --

Q I'm sorry, what was that again? Could you just go over it, I missed you.

A Yes, one of the first things as we indicated in our submission to the NEB, that forms the Foothills submission, we indicated that we reviewed existing data and it was data which AGTL had, that was one of our first was to review the existing data and part of it was the submission by Gas Arctic.

Q I see.

A So this was carried out by myself, Dr. Robert Lowe, Ken Gillespie, and we had

several other staff members that were in this review.

Q And would that review have resulted in a report being prepared for Foothills?

A No sir, it was not a report.

Q You were telling me about the work that had been undertaken by your organization and the people involved in the specific jobs they had, that was the first project undertaken?

A That was the first is that our approach was to review all the existing information with the idea that we would be building upon that base data. That was our approach to the problem.

Q Okay, who are the people with Klohn Leonoff who have been doing work for Foothills and what have they been doing? Mr. Claridge obviously, and Mr. Gillespie we've seen on another panel. Would you just outline the complete roster of the key people who are working and what areas they were working on?

A I guess most of our staff has been working on this. Mr. Edgeworth, geologist, Mr. Waslyk, another geologist; Mr. Bob Rennie, a geotechnical engineer; Mr. Evans, a highways engineer; Mr. Speer, Manager of our Calgary office, and Earl Klohn, president of our company.

Q And Mr. Claridge and Mr. Gillespie?

A That's right.

Q And you, sir, are the director of engineering for Klohn Leonoff, and as I understand it, responsible for engineering carried out in the prairie provinces and the Northwest Territories?

A That is correct.

Q Has your position enabled you to devote any of your time to the Foothills' assignment, or have you been involved in administrative matters?

A I have spent a large portion of my time on this project. It is the main project in which I am involved and have been for the past several months.

Q What I was interested in, sir, is whether or not your involvement was more in the administrative level as opposed, say, to carrying out the various studies that are being done?

A Administrative only in the sense of an engineering sense, not in the -- in a review sense of the data being gathered, rather than a time/money sense.

Q I'm sorry, you lost me in that answer.

A Well, administration is to me in two areas; it's administration of engineering staff in which you are reviewing the work they are doing. You are taking care of directing them in studies and that means that you are taking a direct interest and reviewing what they are doing.

Q Right.

A Administration in another sense is the secretarial pool as to what they are doing, the draughting and that, I am not looking after that.

Q You're involved in the former?

A Right.

Q Now sir, on page 9 of your evidence, you were asked about whether you differed from Arctic Gas in your approach to studying the problems being examined by your company, and you comment on the area of difference that you have been able to detect is that of the emphasis placed on terrain typing. That's in answer 19 on page 9, and then you go on in answer 20, to relate this to the work that has been done in connection with designating erosion control, drainage control and buoyancy control measures. Is that correct, that's really what you're saying was the terrain typing was used for?

A I'm not sure that I quite understand your question there, sir.

Q Well sir, you are asked at question 19, "Have you differed from CAGPL in your approach to studying the problems", and then you go on to say that you are not totally familiar with everything that's been done. Then you say "The only area that I know of in which we may differ from CAGLP is in the emphasis placed on terrain typing". Now, it's that "emphasis placed on terrain typing" that I'm interested in, and in question 20 you were asked what makes you believe there is a difference, and you go on to relate that the terrain mosaic sheets show a proposed or tentative design for erosion control and drainage as well as buoyancy.

A That's correct.

Q Which you tie back into terrain typing, as I understand it.

A That's correct.

Q It's perhaps just a technical matter, sir, but as I understand it, terrain typing results in these air photo maps with lines drawn on them encompassing various terrain types, and when we talk about terrain typing such as Mr. Drew did, or Dr. Mollard did, that's the way we have been using the term. Is that how you understand it?

A That's correct, air photo interpretation.

Q Well air photo interpretation is a much broader discipline, is it not? It is the analysis of air photo mosaics through stereoscopic stereoscopes or whatever they are called, to do, among other things, a terrain typing. That's one of the uses that you can put air photo interpretation to?

A Except really the air photo interpretation, I think terrain typing is a fancy name for air photo interpretation.

Q So by terrain typing, you mean air photo interpretation?

A That is correct.

Q I see. Well, would you agree with me, sir, that air photo interpretation can give you some information on slope angles?

A It can give you a quali-tative sense, a judgment sense, yes.

Q And it can give you some information about drainage patterns?

A Yes.

Q And some information about erosion?

A Yes.

Q And it can give you some information about possible areas where buoyancy control might be required?

A Yes.

Q I'm not suggesting that you have all the information that you would need in order to be able to build the pipeline incorporating all the drainage and erosion control measures and buoyancy control measures simply from an air photo interpretation, but it certainly gives you some information?

A That is correct.

Q Now, I take it that your firm has not used that approach to gather that type of information?

A We have not used air photo interpretation or propose to use it for the final design. It is assisting us in order to lay out the problem areas that we are able, when we do the final design, we will use it as a guideline.

Q But you haven't used air photo interpretation to come up with some sort of a classification system, pertaining to those three aspects?

A No, sir, not as a

classification.

Q Have you done anything else which would enable you to develop a classification system or a preliminary estimate of the needs for drainage and erosion control? Or buoyancy control? Yes, I think I have covered all the subjects.

A Not as a final -- the only means which it's a tool that we are using with other tools in order to arrive at the answer.

Q Well have you developed some sort of an estimate or a preliminary design at this point as to, for example, where buoyancy control would be required?

A This is an area in which we are studying, that we have study sites that we are looking at.

Q It hasn't been completed yet?

A The work has not been completed yet.

Q Would the same answer apply with respect to drainage and erosion control?

A That's correct.

Q And the information on slope angles?

A This information will be information at the study sites has been gathered. The overall lines that would come at final design when the orthophoto mosaicing has been done, as well as the centre line profile surveying has been done.

Q Well Mr. Mirosh, how if you don't have this information, even if it's in a preliminary form about where you are going to need buoyancy control and where you've got potential drainage and erosion control measures to be installed and you have slope problems, how, without that sort of information, even in preliminary form, have you been able to do capital cost estimates or construction estimates?

WITNESS MIROSH:

A Well we did get it at a more preliminary form, perhaps, by having our cost people overfly the route, study maps and from a contractor's sense, prepare cost estimates for these things.

Q Mr. Bauer told us how he did it for buoyancy control. He simply assumed that half the line was going to be weighted with weights of 10,000 pounds, I believe. I may have the figure wrong, but half the line I'm sure is right.

A Yes, he did say 50 percent, but it probably wasn't arrived at that simply.

Q Well if it wasn't a judgment call, if you like, how did he do it? He didn't have the input, the benefit of the work of Klohn Leonoff because that hadn't been done.

A No, but he was aware of where permafrost was and where swamplands are, and in a general sense the miles that are involved that would require buoyancy.

Q And he would get this

information from reconnaissance trips?

MR. HOLLINGWORTH: Aren't these questions for Mr. Bauer to answer, sir?

MR. MARSHALL: Well I think we are doing nicely with Mr. Mirosh.

THE COMMISSIONER: What's --

MR. HOLLINGWORTH: He's going to be back on the construction panel.

THE COMMISSIONER: Well when Mr. Mirosh runs out of answers, it can be picked up with Mr. Bauer. Surely no one is being harmed if Mr. Mirosh is aware of these things.

MR. HOLLINGWORTH: I have no objection as long as it's clear that Mr. Mirosh is only assuming what Mr. Bauer, what went through his head.

MR. MARSHALL: I have every confidence --

MR. SCOTT: Isn't Mr. Mirosh the head man at Foothills?

THE COMMISSIONER: Yes, yes, he is.

MR. MARSHALL: I'm sure he'll tell us if he doesn't know the answer, sir. Won't you?

A Yes, I was saying also using existing photography and mapping.

Q Well what about the estimates of the need to install drainage and erosion control measures?

A Perhaps here I would let

Mr. Bauer answer.

Q I see. You're not able to say how those estimates were derived at so that the costs could be worked out, for cost estimating purposes for your application?

A No, sir.

THE COMMISSIONER: I think, Mr. Marshall, we will adjourn for coffee now. I take it that cross-examination of this panel could well take us into this evening, and I should hope that we could begin the Construction panel tomorrow, but I don't think we will reach Operations and Maintenance, certainly not until Monday. That would seem to be plain enough, if that helps all of you to make your own plans.

MR. MARSHALL: Well sir, I think you may be right. We would propose then not to bring our people to Yellowknife to deal with Operations and Maintenance, and do I take it then that if we get through construction we will simply adjourn until Monday?

THE COMMISSIONER: I would think so.

Well if that helps you in making your plans, and that's your last panel anyway, is Operations and Maintenance. We will adjourn for coffee.

(PROCEEDINGS ADJOURNED)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

CROSS EXAMINATION BY MR. MARSHALL CONT'D:

Q Mr. Mirosh, I believe we left off at the point that Mr. Bauer, who is going to be on the construction panel is going to be able to tell us about how he developed capital cost estimates for buoyancy control measures and drainage and erosion control measures? You would prefer to refer that to him?

A Yes, if that's within the realm of the Inquiry.

Q And Mr. Davison, could you tell me whether or not your firm has advised Mr. Bauer as to drainage and erosion control requirements so that he could have the benefit of your assessment in setting up these capital cost estimates for these items?

WITNESS DAVISON:

A We have not provided any data on that.

Q Just to go back to a point that was left over Dr. Yip with respect to consolidation. I was asking you whether or not the concept was introduced by Dr. Slusachuk earlier in the Inquiry and I provided you with a copy of the page from the transcript. The two of you are talking about the same things?

WITNESS YIP?

A Could I ask Dr. Hwang to comment?

Q Please, Dr. Hwang?

WITNESS HWANG:

A I have read this page

2334 it was not a concept introduced but rather a phenomena which had well known in the field of soil mechanics. The same phenomena.

Q The same phenomena. Now sir, have your studies progressed to the point that you are able to quantify the effect of consolidation, on the various soils to be encountered along the proposed route of the Foothills Pipeline?

A The model we have started at the moment, we have obtained, the one dimensional behaviour, and the result we had has quantified the three portions, that is, in situ frost heaving, expansion of the ice and the consolidation and also the segregation, they had actually quantified.

Q What I'd be interested in having provided for my advisors is the data that pertains to the effect of this consolidation phenomena. Is that available?

A The data, if I recall, just the other day we arrived and Klohn and Leonoff people have some field data between MIle 680, south of Fort Simpson area so we are planning to use that data for quantification, only the case where we have done, the other case we have not finished yet.

Q Do I take it then that you haven't at this point, been able to quantify the effect of the consolidation phenomena because you haven't yet run this through your model?

A You mean actually using the field data?

Q Yes.

A That is true because I only saw the field data report two days ago.

Q I see. This is going to be done though.

A This has to be done.

Q Well we'd be interested in the report that will be generated no doubt once you've been able to run this data through your model.

A Sure, because I have to have a report to put here anyway.

Q Thank you.

Mr. Claridge, could you tell us something about your permafrost experience and when you first became involved in permafrost work?

WITNESS CLARIDGE:

A What's permafrost?

Q Well sir, I'm prepared to work from --

A I'm sorry, that was meant as a joke.

THE COMMISSIONER· That was facetious.

MR.MARSHALL: I guess we're all getting a little sensitive.

I was going to allow him to choose his own definition. You have one in mind?

A Yes I have, as I stated in my experience history, been associated with the Foothills project since I believe I said December of last

year. I have spent most of the time from December until now in working on several aspects of the project, I, of course, have had literature experience throughout my professional history, dating back to, I suppose educational studies at the University of Toronto, so let me summarize, that educationally I've been aware of permafrost problems in northern experience for about ten years. However, I've been directly involved with projects such as Foothills and dike constructions for the Snare River Dam in the Northwest Territories for about nine months.

Q Sir, you indicate in answer to Question 26 on page 10 that field program was initiated during the spring of 1975, to collect data on slope conditions. This would have been the first such field program your company initiated on this project?

A No, that's not correct. The first program of field observations which Mr. Gillespie referred to on the location panel was undertaken in January of 1975, and --

Q Were you involved in that?

A Yes, I was.

Q Mr. Gillespie's reconnaissance or --

A Yes, it was on the same reconnaissance with Mr. Gillespie at that time.

Q I see. I was wondering sir if the results of the field program that you're describing in answer to Question 26, were incorporated

into the geotechnical portion of the Foothills application?

A No they were not.

Q Sir, in answer to question 26, the last line or the last sentence on page 10, you say, "Thus emphasis has been given to the specific conditions along the route as opposed to consideration of a broad region outside of the pipeline corridor." Have you found that passage sir? If you turn back two pages. to Mr. Davison's evidence at the bottom of page 8, he says this, "Concerning the Foothills Pipeline route for the preliminary designs, we are concentrating on gatheringdata on a regional basis along the proposed pipeline corridor."

A I think there's a distinction between region and broad region there. My statement refers by broad I mean -- I think I said at some point within a distance of approximately five miles of the pipeline and by a broad region I mean studies up and down the Mackenzie River, on the west side of the Mackenzie, a number of miles away, which I believeit's a small point, but it is a distinction of the approach we have taken from that of CAGSL that they seem to rely perhaps more heavily than we do on information from other river systems and perhaps at a distance beyond which we consider it to be particularly relevant.

Q Well sir, am I to take it from your answer or from the prepared evidence that when you say that you have emphasized specific conditions along the route, you're meaning the same thing as Mr.

Davison when he says you're concentrating on gathering data on a regional basis?

A Well as I repeat myself, the word regional to us, means let's say within five miles either side of the pipeline. And to a lesser extent beyond that, it's a matter of emphasis.

Q Is consideration been given to route operations within such a range?

A We are concentrating on that corridor which would make a ten mile corridor. This is our area of concentration so it does not imply that we would be considering relocations within that distance. However, we feel the data that we collect there is particularly relevant to the actual pipeline route that we consider.

Q Sir, in the previous answer you indicated that CAGSL had looked at different river systems. I'm just wondering if you could amplify on that? Which ones to your knowledge were involved?

A Well I think there has been a good deal of emphasis placed on the condition of slopes along the Mackenzie River itself for one example. I can think of the Mountain River as another. There are a number of tributaries that feed in on the west side. I don't recall the exact names I'm not precisely familiar with them. I think it's a small point.

Q It's not a different region is it? It's the same or do I have a mistaken idea of geography?

A Different rivers let's say we're going on the east side of the Mackenzie.

Q Now in answer to question 27, on page 11, you deal with what I'm told is called the observational technique. This is a technique that you employ in your studies is it not?

A Yes. we make observations.

Q And this is something that you have now started to initiate in your field programs for Foothills?

A Yes, that is correct. During the spring program referred to, we measured angles of slopes, various categories of slope from some that were failed, to others that were steep to those that the pipeline crosses. In other words we looked at a range of slopes and we have data on those and we are in the process of assimilating that and putting it into a form that we can go into what I would say a process of confirming route location in critical areas such as major river crossings to even preliminary designs of those crossings, such as to confirm the locations proposed.

Q Have you made observations of all the slopes that you want to look at in connection with this proposed pipeline?

A Within the corridor that we are considering, I would say we have looked at, as far as we know, the significant slopes. Of course that's not all the slopes, but the ones we feel are significant.

Q How many would that be, sir?

A Oh, on which we have actual measurements or -- there are varous categories of work that one might do from simply looking at it to perhaps profiling it, to having it surveyed, for example.

Q Well as I understand your evidence later on, and perhaps we will get to it again in more detail, but you have made a point of saying that you don't have a slope classification system. You reject that approach, and you indicate that you feel you really have to examine each slope specifically?

A No, I didn't say we don't have a slope classification system. I think I gave one that we consider a classification, based on whether a slope has failed or it may be steep, and perhaps approaching failure or flat or otherwise.

Q Well we'll come to that, as I say, at a later point.

Now, this observational technique that we have been talking about, this is one that has been in use by consultants to Arctic Gas and indeed

Foothills is relying on a number of their reports and observations of reports, which are referenced in the Foothills' application. Is that correct?

A Yes, that's correct.

Q Specifically, the references are set out in section 3B-2.53 of the Foothills' application, and they are listed as items 2, 13, 19, 20, 21, 28, 31, 34, 36, 37, 38, 11 and -- I'm sorry, 36, 37, 38, 43 and 45, all being reports or studies that have been carried out employing this observational technique by --

A Excuse me a moment, I have just found the page now. Would you repeat them, please?

Q I don't want you to check all of these, sir. The point simply is that Foothills is relying upon these reports --

A I think as Mr. Davison indicated, our first task was to review all of the information that we had available to us at the end of last year, and that pertains to reports at that time, and those we have received in the interim.

Q Now sir, on page 11 of your evidence, in answer to question 27, you say "Evidence gathered from landslides is also useful in back-calculating the soil parameters which can be used in the analysis of other slopes. I was wondering what parameters have been analyzed?

A We are in the process of collecting the data, most of it actually is in our

notebooks, it's in the form of being assembled and related to our specific problems.

Now, the approach that we use in, let us say, if you are getting at how do you analyze a slope, I think we have covered that in the application assessment.

Q I noticed when you read your evidence that when you got to the third line of that paragraph on page 11, in answer to question 27, in the paragraph that's the second from the bottom, when you got to the third line of it, you added three words. The sentence used to read, "Thus, the parameters obtained from laboratory testing can be compared with those obtained by examination and back analysis of landslides", and you changed that to say, "Thus, the parameters which may be obtained from laboratory testing can be compared with those obtained by examination and back analysis of landslides", is that correct?

A Yes, I used that only as far as you may or may not do laboratory testing on a particular site. You would not necessarily test every site that you examine.

Q And I take it you haven't back calculated any of these then?

A No, we haven't since we gained our field data.

Q Now sir, you say that -- further down in the next paragraph on page 11, "A further benefit which is gained from the observation of failed slopes is a knowledge of the causes of the

failure and understanding of landslide causes is useful in deciding on route location, as similar situations where landslides have been observed, can be avoided". I was wondering, sir, whether or not you have been able to report to Foothills as to this matter of failed slopes, or to use your words --

A Are you asking if there has been a formal report issued?

Q Yes.

A No, there has not. We will be preparing one, but I might add that as a secondary part of our field program, we have been planning to examine slopes at various times of the year, particularly following a summer where activity may have developed, and this observational program is presently underway, and we don't propose to begin a report until that data is gathered.

Q Well sir, the reason I raise it is because of your suggestion with which I'll agree, that an understanding of landslide causes is useful in deciding on route location. Now, do I take it then that as you haven't been able to report on this matter to Foothills, that Foothills in deciding upon route location, haven't been able to have the benefit of your advice?

A No, that's not, that's not true --

Q On landslide causes?

A -- as during our spring reconnaissance, also in the January reconnaissance where

we made the observation in examining the proposed route that it was at an unsatisfactory location, such as on a slope that appeared to be excessively steep or where it was failing on the spot, we recommended consideration of a re-routing. These have been passed on instantly to Foothills, as they were also involved on the field examination, and I believe these proposed alternative routings have been examined for -- from other points of view since that time.

Q Now, you were looking at the route as filed in the Foothills' application, were you?

A Yes, initially, that's the initial examination was exactly on that route, and --

Q Well sir, we don't as yet have the benefit of any other route to work from.

A There is no other route.

Q Well I would be interested in knowing, sir, in which areas you made recommendations that the Foothills' route, as contained in its application, be changed?

A I believe that was discussed by Mr. Gillespie and other members of that panel in some detail. I think I could describe several examples, perhaps, of where alternatives are being considered.

Q Well I took it that you were the slope stability expert on the team, and I wanted to know particularly what your recommendations had been

for route relocations, from the point of view of obtaining what you considered to be a more favourable location, having regard to slope stability.

A I would present as one example, the crossing of the Great Bear River, which at the location shown on the mosaics we found to be a difficult one, in that the slope is quite high and quite steep, and we identified two possible alternatives where these conditions did not exist, where there would be much less disruption of the slope through having to cut or to fill, perhaps, at the toe of the slope. One of these alternatives is actively being examined in the field at this point for through drilling.

Q I take it there would have been other recommendations pertaining to unstable slopes?

A Yes, Smith Creek was another one where an unstable slope was being crossed by the pipeline, and we proposed an alternate route to Foothills.

Q Well sir, I don't want to tax your memory too much, but perhaps what you could do is check your files and see what other ones, what other recommendations were made --

A There was a minor revision at Swimming Point as well, where a slope was excessively steep, and we suggested a minor relocation, and I think following that, for environmental reasons, it was relocated again to something like a mile further down stream, from where it is shown. At least this is

again in a state of consideration.

Q Well Mr. Mirosh, do I understand that with respect to the Swimming Point crossing, that as matters presently stand, the selected and preferred crossing from Foothills' point of view is the one shown in the application material?

WITNESS MIROSH:

A That was the selected crossing and preferred at that particular point in time. There is study going on to see if the other alternate which has been mentioned is more preferable.

Q Where would that other alternate be, sir?

A It's downstream of Holmes Creek. I'm not certain of the exact distance, but it's within a mile, I believe, of the crossing shown in the application.

Q And that crossing is, as I recall, just immediately upstream of Holmes Creek?

A Yes, it is upstream. I'm not sure if immediately upstream is correct, but --

Q Perhaps we can get into that later.

Yes sir, when you and I think Mr. Walker with you on the panel the other day were talking about an example of what Foothills considered to be a properly designed crossing, were you talking about the proposed crossing at Swimming Point as shown in the application?

A We were talking in general terms of crossings. That crossing is shown on our application. Certainly if we had to for whatever reason use the crossing which is currently shown then what we said would apply, but if we decide to move it, then also what we said would apply.

Q Mr. Claridge, I was asking you to list for me the various unstable slopes you observed and that you recommended be avoided through relocation of the Foothills line. I was wondering whether or not we had completed the list or there were others. If you can't think of the complete list now, it's quite acceptable that you advise me through your counsel.

WITNESS CLARIDGE:

A I recall Steep Creek as being another one where we proposed a minor modification. Not so much that the slope was unstable, but it was rather steep and it required deep cutting which is undesirable both from geotechnical engineering as well as environmental viewpoint and we recommended a lower slope for the crossing. I think those are the main crossing revisions that we suggested.

Q Thank you, that's very helpful.

Q Sir, would you turn to page 12 of the evidence and specifically answer 28. I refer you to the last sentence of that answer, which says, and this is the point that I said we would get to in due course. You say this " For this reason, no slope steepness criterion has been selected for the pipeline." I thought you were just telling me sir that you did have the criterion or have I got it confused?

A I think you brought up the word classification of slopes. We have a broad classification of slopes but I said that we used no steepness criterion, because slopes may or may not be stable, based on local conditions and we do not propose to apply a single figure such as three degrees I think has been mentioned by Arctic Gas, as applying to whether or not a slope may be unstable.

Q Now sir, you go on to say near the bottom of your -- the bottom of page 12, answer 29, "In every case to date it has been possible to select a pipeline routing which avoids steep slopes and the occurrence of slides of this nature is considered to be extremely unlikely." Have you found that passage?

A Yes.

Q Now sir, you've told me that you don't have a slope steepness criterion, you don't consider that's particularly useful.

A The criterion I refer to is a regional one that would be applied to the entire pipeline. We have no such criterion that applies in that

sense of the entire pipeline. When I say that we avoid steep slopes I'm saying relatively steep slopes. In other words, if you've got a slope that is 70 percent a mile down the river, and it's -- it may or may not have failed and you can find one that is 30 percent, and the soil and terrain conditions appear to be similar, then yousay, well, I've got a good slope, from a local observational viewpoint.

Q Excuse me a moment sir. I tell you the difficulty I have is that you say in every case to date, it is impossible to select a pipeline routing which avoids steep slopes. Now I take it from that that you must have determined which of the slopes are steep slopes and which of the slopes aren't steep slopes all along the pipeline right of way.

A Within each major river crossing, we examined a sufficient sampling of slopes to be able to categorize simply by comparing the angle of the slope which was steep and which was flat in quotation marks. Now which was which may differ from river to river.

Q So you've adopted some sort of a classification system based on steepness?

A I said our classification was based on failed slopes, steep but unfailed slopes. flatter slopes and slopes at the location of the crossing and we try to locate the crossing on the minimum slope that we can and we establish confidence in that slope by relating the angle of that crossing that is suggested

to other slopes in the area, so we do a slope comparison in a given region.

Q Well sir, whether you're using a classification system or a steepness criterion or an individual on the ground assessment of each slope, you're satisfied, are you that you have examined the slopes in enough detail to be able to say with confidence, that in every case to date, it has been possible to select a pipeline routing which avoids steep slopes?

A The statement as such is correct. I would not wish to draw the conclusion that every crossing that has been selected is necessarily the best one because we're in a state of drilling it and observing it over a longer time period.

Q Sir, on page 13 in answer to question 30, the last sentence, reads as follows, "It is our primary intention to select a route location which avoids zones of potentially high erosion and related instability." As I read this, it seems to me you're stating an intention. Do I take it that it's an intention which implies this is something that remains to be done or is this an actuality, have you done this?

A I would say sir that we've done this. But since our final route has not been confirmed, I cannot say that we'll always achieve that but I would say that I'm satisfied we have at this point.

Q I take it you've identified zones of potentially high erosion and related instability

and have advised the route location people at Foothills?

A Correct.

Q Is this found in a report sir?

A No, our studies are not complete for the combined spring and summer program. There has been no report, as such.

Q How do you go about communicating this sort of thing if it's not in report form?

A We carry on very close communications with Foothills. I think particularly, well myself and Mr. Gillespie I know communicate closely and also Mr. Fawcett who is in charge of route location for Foothills is very, very close to us. They're only about four blocks away, we see each other quite frequently.

Q So then your recommendation with respect to route location to avoid zones of potentially high erosion and related instability would have gone to Mr. Fawcett personally?

A I'm sure he's very well aware. He was in fact co-ordinating the spring observational program and we were able to communicate with Mr. Fawcett practically every day after each day's work.

Q What I'm interested in sir is whether or not you have recommended changes from the route that appears in the application. I take it that would be so?

A Yes, we have made a recommendation let's say, through various means to Foothills, many of them verbal.

Q Do you keep a record of that?

A There are records of this, for instance, but they're in a very rough form. They may be just a line on a mosaic sheet.

Q Sir, the problem that we and the people participating in the Inquiry have is that we're trying to look at a Foothills route and we understand that you've made a recommendations that the route, as presented in the application materials be changed to avoid zones of potentially high erosion and related instability. We're interested in knowing what those zones are and what changes you've recommended. Now you've told me that the communications have been orally to the client but you would had some notes and so on. What I'd like to have produced is a list setting out those locations and the recommendations that have been made. I wondered if we might be able to have some-thing of that sort --

A This should be for Mr. Mirosh to decide on policies. There might be other fields that would have an input into deciding whether or not a route re-location is made. We would not make the sole decision.

WITNESS MIROSH:

A I think the point to be made here is that these are recommendations which have

not been necessarily accepted by Foothills and incorporated. They very likely will be, but they reequire analysis by not only Klohn Leonoff but by the environmental people who have been abreast of it but we do have to get together, finalize these changes and as I say, when we do this, we will then be preparing a new altered route which will not be significantly different from what we're talking about but a refinement.

Q Well, will this altered route be available for presentation to the inquiry?

A Well it won't be available during the next few weeks, and we're hoping to have it within a few months.

Q Well I wonder if we might have, in any event, the list of recommendations that have been made, Mr. Claridge by you with respect to route relocation to avoid zones of essentially high erosion and related instability? Might we have that, Mr. Hollingworth?

MR. HOLLINGWORTH: I see no objection to providing it, subject to the usual reservations we have.

MR. MARSHALL: Well it's not an item you are claiming privilege for, is it?

MR. HOLLINGWORTH: Not that I'm aware.

MR. MARSHALL:

Q I wonder too, Mr. Mirosh, if we might be advised as to whether or not Foothills has accepted any of these recommendations that will be listed? It may be that none of them have yet been decided upon.

MR. HOLLINGWORTH: I think Mr. Mirosh has just finished pointing out to you that the evaluation hasn't been completed yet, Mr. Marshall, so I don't really see how he can tell you whether they have been accepted or not.

MR. MARSHALL: Well, sir, this

is precisely the point, as I recall, that was raised with Arctic Gas witnesses, and they were asked to indicate which changes they had recommended for the various reasons that are important in deciding upon matters such as route location. I don't really think I am asking for anything more than has already been found to be necessary for purposes of the Inquiry.

MR. HOLLINGWORTH: I'm not saying that we can't produce it in time, I'm saying we can't produce it now. That's implicit in Mr. Mirosh's answer, I believe.

MR. MARSHALL: Well, it seems to me it could be fairly simply done if Mr. Claridge could give a list of whatever number of recommended changes he's made; if Mr. Mirosh could indicate whether or not those changes will be made or will not be made, or he has not made a decision on it.

I suppose, depending on what sort of information we get out of that, that may well be satisfactory for now.

MR. HOLLINGWORTH: I thought he said he hadn't decided on any of them, so that would seem to me the end of the issue.

WITNESS MIROSH: Am I to take it, sir, that I am providing what Mr. Marshall is requesting? You nodded your head in the affirmative, and I wasn't quite sure what that meant.

MR.HOLLINGWORTH: It seems to me the question has been answered, the second prong of the question.

THE COMMISSIONER: I wasn't paying as close attention to that argument as I should

have been, I guess.

MR. MARSHALL: You can tell it is 4:30 of the second day on which there are going to be sittings in the evening.

The question, or the information that I am seeking is this, sir. Mr. Claridge has told us that he's made recommendations orally for route relocations to avoid zones of potentially high erosion and related instability and --

THE COMMISSIONER: As he said, it would take a few weeks or a few months to be able to present us with the revised route.

MR. MARSHALL: Well no, sir, this is Mr. Claridge. It's an historical fact that such recommendations have been made. They were made orally but there are notes, and what I have asked is that there be a list prepared of these various recommendations, that's the first leg of it, if you like.

THE COMMISSIONER: All right.

MR. HOLLINGWORTH: We have no objection.

MR. MARSHALL: Mr. Hollingworth's first prong --

THE COMMISSIONER: All right, so you can get those.

MR. MARSHALL: I can get those, and the second point was, I wanted to know whether or

not Foothills had decided to accept or reject, or had simply not yet got to the point of making up its mind about these recommendations.

MR. HOLLINGWORTH: And my point is that Mr. Mirosh as I understood it, had already said that no decision had been made on these.

MR. MARSHALL: Well then simply he need say we have not made our decision about any of these --

MR. HOLLINGWORTH: You mean he needs to write it down for you besides giving it to you in testimony today?

I mean we are getting into the point of useless exercises.

MR. MARSHALL: I scarcely think it's useless. Mr. Mirosh can say whatever the facts happen to be.

THE COMMISSIONER: Do you want to add something, Mr. Mirosh?

WITNESS MIROSH:

A I was just going to say that we haven't decided whether we would use these recommendations. I'm sure we will, but we just have not all sat down together to go over them and accept them.

MR. MARSHALL:

Q Well that's fine. Now I know when I get the list that they are still recommendations that are in limbo.

THE COMMISSIONER: Under

consideration.

MR. MARSHALL: Under consideration, yes, sir.

Q Might we be advised when Foothills does make up its mind with respect to these recommendations?

THE COMMISSIONER: Well the inquiry would want to be advised if there are revisions in the route.

MR. HOLLINGWORTH: Again, Mr. Mirosh said a new route would be filed at that time. It seems to me that was also implicit in the answer that he has given previously.

MR. MARSHALL: Well sir, we have undertaken to advise the Inquiry when serious consideration is being given to route relocation, so that the Inquiry can have that information, it can be assessed as the various evidence is being considered, and it's really that sort of thing that I'm -- that I think ought to apply also to Foothills.

THE COMMISSIONER: Well I think it ought to. What do you say, Mr. Scott?

MR. SCOTT: I understood that Arctic Gas was to let us have, and I think they did in some particulars when requested, and recommendations that were accepted, recommendations that were not accepted is as far as we asked for them and recommendations that were in limbo, that is, had not been passed.

It seems to me that Foothills should submit to the same kind of rules. They might

have a race to see whether they can get their recommendations in before us before Arctic Gas decides, for example, on the Cross Delta route, but apart from the race aspect of it, it seems to me that what is fair for Arctic Gas, should be fair for Foothills.

MR. HOLLINGWORTH: Well that's quite true, sir. We are not interested in a race, we are interested in presenting a quality pipeline application, but I think that the answer has already been given, that all the things are presently in limbo.

I can produce paper, I'm sure Mr. Mirosh can produce a paper that says the same thing as he said here today. I'm just concerned that there has been a lot of requests made for paper work, and I am questioning the use of some of them, inasmuch as answers have already been given which would just be repeated in print.

We are quite prepared to provide the Inquiry later on with what recommendations have been accepted, what have been rejected, and keep the Inquiry fully abreast as to the developments in Foothills Pipe Lines, but I think we are being asked now for something, the answer to which has already been given.

THE COMMISSIONER: That's a point, Mr. Marshall. How far do we have to go with this? You weren't required to bring the Inquiry, the recommendations being put before Arctic Gas before you had had a chance to say yes or no to them, but once you said yes or no, we said to you, well bring them before

us and tell us what you have decided to do. How can we expect Foothills to do more than that?

MR. MARSHALL: I think the request made of Arctic Gas was that it advise the Inquiry when it is giving serious consideration to a route revision.

THE COMMISSIONER: Well that certainly was applied to the Cross Delta route but that's in a class by itself in a sense, isn't it.

MR. SCOTT: Mr Commissioner, as I recall, Arctic Gas did undertake. I don't think they were really asked to, but they did undertake to give us notice in some detail of any, I think this word is not inappropriate, any major route relocation that was being considered, as it was being considered, with a view to avoiding the kind of thing that might happen when a substantial route change was sprung on us, if I may put it that way, at the last moment, without warning. Now the difficulty, as I perceive it, is that Foothills may not today be at the stage it was at. that Arctic Gas was at when it was asked to make that kind of undertaking. If their route is in no sense fixed because much of this work is in progress, it might be at this stage, if it is that flexible, that it is unreasonable to ask them to do that. But if this is a fixed route, it seems to me that they should be required to give us notice of major relocations that are being seriously considered.

MR. HOLLINGWORTH: AT a future date.

MR. SCOTT: When they're being seriously considered.

MR. HOLLINGWORTH: No problem

there Mr. Scott. My problem was was to providing a sheet of paper now which said Mr. Mirosh has already responded to in answer to Mr Marshall.

MR. MARSHALL: That's fine sir. I take it though that with respect to Mr. Claridge's recommendations, not all of which he could remember off the top of his head, we will be receiving a letter or some information from my friend setting out what other recommendations have been made for route changes. Now this is I think --

MR. HOLLINGWORTH: I've already said we'd provide that.

MR. MARSHALL: Okay, fine, thank you.

THE COMMISSIONER: Anything else you want me to rule on?

MR.HOLLINGWORTH: I was going to say go back to sleep. But I thought it would be a little rude.

THE COMMISSIONER: Not yet.

MR SCOTT: Can I emphasize why that is important to the Inquiry, that this kind of notice be given by both Arctic Gas and Foothills. Now take the Swimming Point problem about which we've had some evidence, that in cross-examination, it's apparent that I think both of the applicants, both applicants are considering alterations there. Now that's their right and they're obviously considering them with the best interests of their pipeline in mind but when one comes to prepare one's evidence in Phase II, III and IV, and that's what everybody is doing now, you say to

your experts in Phase II, II and IV, this is where it is going to cross. Now if you ask your experts to consider that, without knowledge that an alternation is in the works or being seriously considered obviously the work is going to be entirely wasted, if subsequently we're told, "Oh well, we changed our mind. for good reasons, we're going to go there rather than there. So I would hope, it's very difficult to police, undoubtedly impossible, but I would hope that both applicants would make full disclosure as these matters arise. If they don't it's going to mean that Phases II, III and IV are maybe very prolonged. If we hadn't found out for example, in discovery of a previous panel. or cross-examination of a previous panel, that there was an alternation contemplated, at Swimming Point, we would not be in a position to prepare ourselves for Phases II and III. That information came out, but I hope in the future it will be volunteered by both applicants so we will know about it.

MR. HOLLINGWORTH: I think Mr. Scott's point is a very good one sir. The only concern to me is that there's almost a limit to that type of recommendation. Sort of paralleling your example, you could have two people flying along in a plane, they look down, they say. Gee, we ought to go up that slope instead of that one over there, and I don't think that that is the sort of thing that Mr. Scott is contemplating that we ought to studiously report to the Inquiry from time to time. I'm just wondering what extent really what degree of seriousness is going to attach to a

recommendation before it becomes germane to the inquiry. It seems to me otherwise the inquiry might be inundated with all sorts of possibilities that are no more than that and have no hope of becoming more than a possibility. I appreciate the concern Mr. Scott has raised but I just hope that he understands the problems that we have in presenting this sort of thing to the inquiry.

MR. SCOTT: I won't trouble my friends with it any further, but the problem that Mr. Hollingworth has, I say respectfully, with great respect, is that it seems to me that his route cannot be said to be at the same stage of finality as Arctic Gas's. Now I don't make any criticism of that, I think that's a natural and normal and quite proper thing, if after six months, it's at the stage of finality that Arctic Gas's is, that would be almost a matter of criticism. Now they're at an earlier stage in the process. I'm prepared to concede that he may have difficulty in giving details, but on the other hand, I hope he will recognize that we understand that because of the stage his client is at. The thought that Foothills should be judged in this point in time in the same way as Arctic Gas is, which is apparently what he asks, frankly does cause me some difficulty.

MR. HOLLINGWOTH: I wasn't asking that, I was just pointing out that there are difficulties in doing as Mr. Scott requires although I do fully recognize the seriousness of his remarks.

THE COMMISSIONER: Well there are difficulties but if you could follow the procedure that Arctic Gas did with the Cross Delta route which is to say, this is a matter being given serious consideration, here is all the material we have, and it seems to me that's the way to proceed.

MR. MARSHALL:
Q Mr. Claridge, on page 13 of your evidence, in answer to question 31, you talk about your field studies which have shown that sheet flow, as it is known, is -- and you go on to describe what it is. I was wondering, sir, if you have some reports on that?
A We have,again we are in the stage of observing our study areas in the late summer at this time, and we will be presenting the information at least on drawings and proposing. We look at what we are doing in the study areas as developing methods for treating drainage, and the eventual outcome of this will be a long-term thing, because we alone do not make the decisions. Again, we must refer them to environmental people and I'm sure others, but what we do, at least in a basic map form, we will be presenting, eventually when we finish our studies.
Q Sir, all I wanted to know was if you had a report?
A No, we don't have a report, as such.
Q Thank you. You say further on the page, in answer to question 31, "Further, that portion of flow occurring in the active layer has been determined to be a small proportion of the total flow occurring during runoff". There's no report as you have indicated?
A Just calculations.
Q I see. Could you tell me what results you got?

A Compared to a runoff flow, I would say we are well under one percent of the active layer contribution to flow.

Q Has this been measured, sir?

A Yes it has.

Q Sir, on page 14, in answer to question 32, you list the types of protection that will be instituted at the time of construction. You make reference to granular blankets, vegetation, mats and mulches, and sand-cement sacks. Have you found the reference?

A Yes.

Q Have you done any estimates of quantities that will be required for these measures?

A We are not at that stage, rather we are developing methods of controlling water which crosses the pipeline in our study areas, and we feel that when you look at quantities, you are talking about a design along the entire pipeline, and we do not feel that is a stage that is warranted. That's a final design stage.

Q Over on page 15, sir, in answer to question 32, you are dealing with sealants, such as spray asphalt or clay bentonite. Have you found the reference there?

A I know what you are talking about.

Q Yes, have you done any estimates as to the quantities of these substances that

might be used?

A I would repeat my answer. That's a final design consideration, and we do not intend to be at that stage at this point.

Q Sir, on page 16 in your evidence, in answer to question 34, you deal with the Ebbutt Hills. We had previously been told that the reason for going around the Ebbutt Hills was because of an I.B.P. site which you'll see is marked on the large Foothills' map that is immediately behind your head. There's Ebbutt Hills I.B.P. site and the Foothills' line going around it. I take it you're telling us you think there is another reason to go around the Ebbutt Hills?

A Yes, that's from a geo-technical viewpoint, we would prefer to be in the present route as shown on the mosaics.

Q Well sir, you indicate that you haven't got field studies and so on, but you state the Ebbutt Hills have a --

A Where necessary --

Q I beg your pardon?

A I think we did, sir. We have not performed field study which would permit a quantitative comparison, but we have done some study.

Q Well maybe you could tell me what you've done?

A One of our drainage study areas was located adjacent to the Ebbutt Hills at mile point 631.

Q What work have you done on the Hills themselves?

A We have flown over them, that's about it.

Q So you make a statement here that a large portion of the route over the Hills, I take it, I'm adding parenthetically, can be expected to pass through the permafrost. Well, my advisors tell me that the vast majority of the Ebbutt Hills is frozen, 80 to 90 percent. You wouldn't disagree with that, would you, sir?

A It sounds reasonable.

Q Well then with a chilled line which Foothills will be operating in this area, aren't they better off going over the hills than skirting around them through terrain that is to a much lesser degree frozen?

A From what point of view?

Q Because of frost heave, sir?

A I don't profess to describe the effects of frost heave. That's Dr. Hwang and Dr. Yip's area, however, there are other aspects to consider. The right-of-way is cleared, for example you remove the tree cover, and this has an effect on disturbance on disturbing the terrain and where you cross slopes, and interrupt drainage.

I view this as being a more possible -- a greater possibility of a detrimental effect of where you pass through permafrost than where

you do not.

Q Well, do you know if this route around the Ebbutt Hills was chosen because of your concern with degradation of the permafrost?

A No, we were presented with the route, however we concur with the selection.

Q Well do I take it sir that yout answer here doesn't really take into account the aspect of geotechnical work pertaining to frost heave? You're not an expert on frost heave?

A I'm not involved with that.

Q And in giving this answer to question 34, you're not taking frost heave considerations into the equation?

A Since my reference is to a combination of slope stability and drainage erosion, the comment is strictly with regard to that. Frost heave is separate.

Q Well I think in an earlier answer you said it was because of geotechnical reasons and you're limiting that now, are you?

A Within the context of what I've written, slope stability drainage erosion,

Q Has someone else within your organization at Klohn Leonoff looked at this route from the point of view of frost heave problems?

A No sir.

THE COMMISSIONER: No one at Foothills either then?

WITNESS MIROSH:

A Sir, we've been studying frost heave in a general sense, we haven't been site specific in that the model is still being developed and worked on but we intend to utilize that model to be site

specific.

THE COMMISSIONER: Well the answer is no, we're not being critical of you but that's where we're at.

MR. MARSHALL:

Q Well Mr. Mirosh. have your studies gone to the point that you know whether or not there's a greater or lesser potential for frost heave, when you skirt the Hills as Foothills proposes to do rather than going over them?

A I don't recall what the type of soil or the water conditions are at the location of our route right now.

Q Well does anyone else on the panel care to answer the question?

WITNESS CLARIDGE:

A Well my own viewpoint, in that area is at the present route that there's a good deal of RKM. in other words, Ridge and Knol Moraine there. We would not expect that to be let's say particularly ice rich, and we feel would be a good route. I might add that no decision has been made. Mr. Mirosh, correct me if I'm wrong, as to where to cease chilling the line. That it could very well if frost heave were found to be a problem, the chilling could be stopped, to the north of this region.

MR. MARSHALL:

Sir, I obviously won't finish the questions I have in this afternoon's session. Did you wish to proceed to five, that's quite convenient to me. If you wanted to stop earlier, this might be a

convenient breaking point.

THE COMMISSIONER: Well there's been some suggestion that the time will come when the Commissioner should stop I guess we'd better. Well we'll come back at 8:00 tonight for an hour and a half if you don't mind.

MR. MARSHALL: That's fine.

MR BAYLY: I'm disappearing after today to catch a plane. Would it be possible for me to do my cross-examination at some point during the evening.

THE COMMISSIONER: Certainly.

MR. BAYLY: I prefer that to trying to instruct ----

THE COMMISSIONER: Oh of course, well why not first thing tonight, 8:00.

MR. MARSHALL: That's certainly fine sir. I'm quite happy to allow Mr. Bayly to go ahead.

(PROCEEDINGS ADJOURNED TO 8:00 P.M.)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. BAYLY: Yes, Mr. Commissioner.

CROSS-EXAMINATION BY MR. BAYLY:

Q If I could address my first questions to MR. Claridge. Mr. Claridge, you referred in your evidence to having taken two reconnaissance trips over the line for the purpose of examining slopes. Now, I take it that considerably more work will have to be done, and I would like to know if you could give me some sort of an estimate of the amount of time or the number of trips that will have to be done before you will be satisfied that you have learned enough about the slopes in the area to make the recommendations in the fashion you would like to make them to Foothills?

WITNESS CLARIDGE:

A I can only comment on our present phase, we are engaged in our third trip, if I can use the collective "we". Mr. Gillespie is presently on a trip, and this would I suggest complete the preliminary phase such that we will be able to establish the route corridor as such.

The remaining work to be done then would be final design, which I think is some way down the road. I do not feel I should be commenting on

that at this point, perhaps. This is a policy that would depend on various decisions by others, regulatory authorities, this Commission, Foothills themselves, I don't feel I could comment.

Q Now, following the third trip, which I take it from your evidence is in progress now and that you have people in the field, will you be in a position to make some sort of a report on slope characteristics and the ways of dealing with them in pipeline construction that will be presented to Foothills?

A Yes, I think we would be in a position to make a report or reports as far as what we are trying to accomplish at this point, and that is to define a route corridor, and we would be making available the base data that we were obtaining in support of that.

Q And apart from studies which will be directed to looking at the slopes, will you be doing any field experiments on the reactions of slopes to various things, for example fire, floods, rainfall, et cetera?

A We are looking at slopes that have been exposed to fires and, for instance, those that are in a state of failure, we're observing the progress of failure from one trip to another, and for example, where there may have been a disturbance that seems to affect the condition of the slope, we are probing that from spring through the end of the summer, and trying to establish, for instance, is the active layer affected, and is there any evidence of, for

example, creep this type of thing.

Experiments as such, while I would say while we are drilling at some of these areas to give us an idea of the soil conditions, but by no means will we have all the data necessary to do a final design. I would like to make that clear, that would be a separate exercise.

Q Now, I take it you have been working on this project for less than the period of a year at this point, is that correct?

A That's right.

Q Now, in order to do this kind of assessment, just from a simple layman's point of view, it appears that you would want to see what happens in all seasons to the ground and various creep areas, et cetera, that you will be studying. Would that be fair to say?

A This is what we are trying to do, that's correct. We have seen it in the winter, and when I say "we", there are a number of people working on the program and we cooperate, but winter and spring and summer and -- I think we are doing that, at least we are bounding the seasons. It's impossible, of course, to be there 12 months in the year.

Q I can understand that. Are there some sorts of conditions that you would like to have more than a single calendar year to look at so that you could see the reactions of more than one season, and perhaps you would need several under sore circumstances to, for example, check on rates of disintegration

of slopes, et cetera?

A I think the indications are that there will be lots of time to observe any slopes that are active before permission is given to build --

Q You have been watching this Inquiry, have you?

A This would be continued, I think through final design, and even through construction there would be continual observations, and I'm sure this will take a period of years.

Q I would like to refer to page 13 in your prepared evidence, and you outlined in the answer to question 30 some possible solutions to slope failures, and one of the concerns that I have is whether you have developed any contingency plans for going in to do corrective measures on slopes, in seasons other than the construction season that's planned to be used by Foothills?

A I would refer that to Mr. Mirosh, because I think that's an operation and maintenance consideration. I believe he was commenting on that the other day.

Q Mr. Mirosh, I don't want you to treat this just as an Operations and Maintenance question, in that I will suggest to you that in order to design your pipeline, you may want to design it in such a way as to avoid the necessity to go in, and that has something to do with the geotechnical aspects as well as Operations and Maintenance?

WITNESS MIROSH:

A Yes, well I won't add too much right now, except to say that we do anticipate, of course, carrying on a clean-up operation after the pipeline is installed, which would include the necessary works in order to stabilize the slopes where there may not be stable from the first go-round. We plan on stock-piles of material, borrow material at certain areas for Operations and Maintenance use, so we do expect to plan for these contingencies.

Q Would you anticipate recommending to the applicant only to do corrective measures on slopes where the integrity of the pipeline is threatened, or would you plan on doing slope correction where it is an environmental or aesthetic question?

A Well I think we feel that the two requirements go hand-in-hand, so the answer to your question would be yes.

Q That's a difficult question to answer yes to, but I can appreciate your feeling that there won't be a situation -- let me put it to you this way. Do I understand your answer to mean that you don't envisage a situation where slope failure would not in some way endanger the integrity of the pipeline, and would therefore have to be looked at?

A Well I think --

Q From that point of view?

A -- I think the slopes that we would be disturbing and of course restabilizing, would be the ones on the pipeline route, and this would

-- these would be the ones which would concern both the pipeline integrity and the environmental integrity.

Q On page 4 of the prepared evidence, and perhaps we can go back to Mr. Claridge on this question, page 14, in question 32 you again refer to various methods of treatment of slope failures, and I want to know whether you have been in touch with your environmental consultants to determine whether some of the compounds you intend to use, the spray asphalt, the sand-cement sacks, and I'm going on to page 15 as well here, and some of the things like clay bentonite, will have any effect on the surrounding environment that should be studied before you determine that this is the method to use to correct the failures?

WITNESS CLARIDGE:

A Myself I have not been in touch with them, I think Mr. Mirosh mentioned the other day that we would be making our proposals and they're in a state of formation, and then they would be passed over to the environmentalists for their comments and we would, I think I mentioned, that we would be in a continual stage of reassessing, according to their comments and others. My own comment would be that we would rely very heavily on a surface mulching and revegetation that would the first line of defense against seepage. I do not foresee there will be a real contamination problem. We try to protect against that, but this would certainly be referred.

Q One of my concerns, in answer to a similar question from Mr.Marshall, you said that the matter of the various compounds that are mentioned on page 15, in answer to this question, would be left to a final design and I'm wondering whether we will have the benefit of the advice of your environmental consultants on these compounds at this inquiry?

A I think they'd probably be making a lot of the decisions themselves on the best form of erosion protection as far as all of these items are concerned. These are simply our idea, or my idea at any rate of what would be used, but I think the vegetation experts and so on, would be probably making the final decision on that.

Q How vegetation grow through this spray asphalt?

A It's, to my limited knowledge,

it's not like asphalt on the highway, it's a compound of various oils. I don't know, I couldn't name you what, but I know types of so-called asphalt have been used, even to revegetate a rock pile for coal mining operations. It's amazing enough but grass seems to grow on it, so there are treatments that use this compound that I think are successful.

Q You have referred to vegetative mats and one of the things that Arctic Gas has talked of, is where they are beyond the tree line and you don't have that concern except in the very northerly portion and the northeast side of the delta. They plan to remove the tundra map and replace it as a sort of a mulch, as I understand their evidence. Would that be the technique you would anticipate using?

A We have not discussed that.

Q And will you be discussing that in a way that will be able to come before the Inquiry. You may not be able to answer that. that may be something for Mr. Mirosh to consider.

In other words, Mr. Mirosh, I'm interested in your schedule of this kind of work so that I will know whether we will be able to look into this through witnesses that will be called.

WITNESS MIROSH:

A Yes I'm sure you'll be able to examine the environmental witnesses which will be forthcoming on that matter. They are more directly concerned with such items as revegetation. That would

be within the scope of their activities.

Q Now one of the concerns that was expressed in Alaska when that project was being assessed was that revegetation of a berm over a pipeline might run into problems because the soil mound might be made up of chunks, frozen material, that would catch moisture and that would not take vegetation as well as if it were pulverized. Have you any plans to take this material that will become the berm and -- have you any plans to turn that into a finer grained material than whatever comes out with the ditcher or blaster?

A Yes, where we -- certainly where we do some blasting to remove the ditch material, it will come out in large chunks and we have discussed reducing this material. But you did mention Alaska and we will be observing their procedures there. I'm sure we'll be able to adopt some methods from what is going on there. I might mention that revegetation on some of the Alaska cuts that we have seen recently has taken very well on the side slopes of cuts. We don't expect that they will have problems nor we in revegetation from what we've seen.

Q Thank you.

Now Mr. Spafford, if I could turn to your evidence please. As it deals with stream flow if you could turn to page 17 of your prepared evidence, question 38, and I won't read the question, but the interpretation I take from that question is that you have assessed characteristics of stream flow

without necessarily referring to field studies on any particular river that drains into the Mackenzie, is that in fact the case?

WITNESS SPAFFORD:

A No, it is with reference to two specific rivers but not in terms of field investigation.

Q All right now, can you tell us which rivers the conclusions and assessments are based on and upon whose field studies you were depending, if any, in order to make this assessment?

A The rivers are listed in that document that is referred to in the evidence and they include all the streams of any appreciable size that cross the pipeline route.

Q All right, now Unies Limited as I understand has not actually done any field work on the rivers, for the purpose of this assessment.

A That's correct. The field work used consists of -- or the field data consists of weather data and a few existing stream flow data were used for correlation of our methods.

Q All right, when you say a few existing stream flow data, may I refer you to the work that you did for the Environment Protection Board. That, Mr. Commissioner, I've had the volume placed on your desk, is Volume IV of the Environmental Impact Assessment, and the report begins at page 177. That report at page 177, if I can read from the second

paragraph on that page, says that"however, most of the streams crossed by the pipeline have never been gauged. In the absence of such data, a theoretical approach was taken to describe the physical setting of bodies of water influenced by the pipeline." Now I realize that that work was completed prior to your doing consultant work for Foothills Pipeline but does that sum up to the present, approximately the state of the art, as it relates to the river?

A That's right, there is an extension of this study, was reported to Foothills and through an oversight I left it out of my evidence.

Q All right, could we have the name of that so that we could refer to it at a later time?

A I will have to get the name of it for you. I'm afraid, but the name is roughly the same as the name on this as I recall but anyhow that is another report. All it has in it is a summary of the same sort of data for the portion of the pipeline route that's not common.

Q Now, in that report that you prepared, subsequent to the one in the --

MR. HOLLINGWORTH: Do you want the name of the document or the document itself?

MR. BAYLY: Well I understand that it was only left off as an oversight. I'm assuming that Mr. Spafford will supply my learned friend with a copy or at least the name of it, and it will be listed as a document which is relevant, and if I want a copy, I will ask if I can have a look at one.

MR. MARSHALL: Sir, I hate to interrupt Mr. Bayly, because I know he's in a hurry because of commitments to leave town tonight --

MR. BAYLY: I hope I don't seem that way.

MR. MARSHALL: Sir, really we are in a very difficult position, trying to do an assessment of the evidence of this panel, without the reports. Now we find that there is another report, and a major report, it seems, because it assesses the rivers, for all the portions of the route that aren't common, and it's just now being disclosed when the witness is on the stand.

I do appreciate that Mr. Gibbs

has been under some time constraints to get this material out, but how are we to cope with this panel's evidence if we haven't the reports in front of us?

THE COMMISSIONER: Well we have to do the best we can, and I think this document should be produced.

MR. HOLLINGWORTH: We certainly have no objection to doing that, sir. Possibly we could have some elaboration from Mr. Spafford. It sounded to me as if it was a document done for the Environmental Protection Board, and it may well be on their list of materials.

WITNESS SPAFFORD:

A No, it was done for Foothills.

MR. HOLLINGWORTH: I will withdraw that one.

MR. SCOTT: Maybe Mr. Spafford could provide Mr. Hollingworth with that.

THE COMMISSIONER: Carry on, Mr. Bayly.

MR. BAYLY: Thank you, Mr. Commissioner.

Q In any event, that report, Mr. Spafford, I gather is an up-dating of some of the data or --

A No, it provides a tabulation similar to the one in this report for all the streams, and it also contains more or less the same text that appears in the Foothills' submission.

For the pipeline.

Q You have referred to the table in this report at page 188 --

A Page 188, yes.

Q And that's the one that goes through the various rivers and types them as -- by their gradient and by their carrying capacity?

A It gives a certain amount of basin data, plus the estimated one and two year, and one in a hundred year floods, and the change in suspended solids, based on the universal soil loss equations,with and without pipeline.

Q Now, in that --

MR. MARSHALL: I'm sorry sir, I can't hear.

A I will go through that again then. It contains various cachement data, the one in two year and one in one hundred year flood estimates, and an estimate based on the universal soil loss equations of the potential suspended solids in the stream before and after pipeline activity.

MR. MARSHALL: Thank you, sir.

MR. BAYLY:

Q Now Mr. Spafford, in the report done for the E.P.B., you talk about stream crossing excavation at page 202, and you refer to a method of construction proposed for the crossing of small streams, that is -- and if I can read from that into the record, "The method of construction proposed will involve winter excavation of a trench across the stream

beds, except on the major rivers. Most of the streams crossed in this way will not be flowing in the winter, and all of the excavated material unsuitable for back-fill will be wasted onto the ice. These materials will be dropped into the stream at the time of break-up, either at the crossing or at some distance downstream, after being transported on the floating ice", and it goes on to discuss some of the effects of this.

Now, we've had some evidence from earlier Foothills' panels on a similar method of crossing small streams, and would this be a method of crossing small streams that you would recommend to Foothills?

A Not necessarily. No, this was having been written specifically for the E.P.B.

Q I can appreciate that.

A It was to point out the possibility of a problem --

Q Can you --

A -- and I think the idea in putting that sort of thing in the report, is so that if that particular type of activity did create a problem, one would do something to guard against it.

Q Yes, and actually earlier in your reports, you expressed some concern at page 185 concerning small streams, your conclusion at the top of page 185, in your summary and conclusions being "Only the smallest streams are likely to experience noticeable increases in suspended sediment concentration

because on these the potential exists for disturbing a significant fraction of the total watershed vegetative cover". Would that be the kind of concern you might express?

A Well this is different than the one, the last one in this case, we are talking about the actual area of the basin disturbed by the pipeline right-of-way, and this computation, the table, shows -- it is intended to show on what streams there may be a problem. What it showed us also was that problems do occur on these small streams with suspended sediments, because a great proportion of their drainage area is disturbed by pipeline activity.

Q All right. Now, I don't know if Foothills is going to be asking you or somebody else, but assume they were asking you, how do we cross the small streams, what sort of recommendations would you give as to the work that should be done before deciding on a stream by stream basis how the various streams should be crossed?

A Well they haven't asked me that question yet, and I would prefer not to try and answer off the top of my head, because it requires some consideration.

Q All right, I don't want you to do it for individual streams, but if they came to you with a contract saying "Spafford, find out for us what we should know about the streams before crossing them", can you give us an idea of the kinds of works that you would anticipate doing as an engineer

in order to give them some recommendations?

A I can provide some. One example would be on the streams where the crossing was intended to be made in winter. An obvious thing to find out is if there is any flow during the winter and how much.

Q Any?

A Any flow in the stream during the winter and how much.

The other sort of things that I might be asked are what the erosion characteristics of the material that was being excavated was, and how it would react to flows in the spring.

Q Now just taking those two things as examples, how much lead time would you need to be able to give those kind of recommendations on an individual stream, how many seasons either of the four in the year, or how many years would you need in order to give this kind of recommendation to the applicant?

A Well, I could never have too much lead time, but there should be a season, a full season of observation probably. There again, I should qualify it because it depends on whether the crossing is going to be made in winter or not. Certainly I would prefer to see an observation of the winter flow in the stream.

Q All right, so if it were a matter that was left for what is popularly called "final design", your recommendation would be that you would have to see a winter crossing contemplated, a

stream --

A The crossings need to be examined in the field.

Q Yes.

A At the appropriate season.

Q Right, so it couldn't be done, say, necessarily 20 miles ahead of the trencher?

A No, not for that sort of thing.

Q And I take it in conjunction with your kinds of studies, that if we were going to have an environmental input, there would have to be some fish biologists, et cetera, to have a look at this at the same time that the engineers were having a look at it?

A That's correct, and in fact, the -- that aspect of it can be looked at and is being looked at already, for most of the streams where they feel that there could be a necrotic problem.

Q All right, now just so that I can confirm this, I understand that you haven't done this work --

A No.

Q -- and I just checked with Mr. Mirosh to see whether anybody else has done the kind of work that Mr. Spafford has outlined up to this point for Foothills?

WITNESS MIROSH:

A Well our environmental people, together with Lombard North, have had some

discussions with myself and others in the engineering department, regarding small stream crossings, particularly where a flow does exist in the winter time. They have proposed to us, and we haven't had a chance to look at it, a culvert method which would allow flow to by-pass the area where the pipeline would be installed.

I think in view of the fact we haven't examined this yet, I won't say any more, but it is being looked at, and it is a method, I understand, that has been or is being applied elsewhere.

Q All right now, is a culvert, Mr. Spafford, something that will take care of winter flow, or is it mainly designed for the season when there is no ice cover?

WITNESS SPAFFORD:

A No, it should take care of winter flow.

Q All right, and you have referred in both your prepared evidence and in the report in the E.P.B. volume, to spring water that may flow during the winter, I gather in streams, would a culvert take care of that kind of water, or -- because some of it's in the sediments, would it not?

A It would take care of that kind of water, even if it were the sediment, as a means of passing whatever discharge there is in the streambed across the site.

Q Right. Now, one of your concerns in your E.P.B. report, and I refer again to

page 185 where the concerns are listed, is borrow operations in the stream beds themselves. Now, to be fair to Foothills, Mr. Commissioner, the report's basic concern is on streams flowing into the Beaufort Sea, off the north slope of the Yukon, which have been described in other evidence.

I take it, however, that given that even, that borrow is a problem in stream beds because of the things it does to the upstream gradients and erosion patterns, is that fair to say?

A That is correct.

Q And at the time of the preparation of the report for the EPB, one of the concerns that your report states didn't get looked into was the effect downstream of a borrowing operation.

A I don't think any of the effects were looked into in detail. There were some streams on which there was a possibility of appreciable borrowing would be done, and the statement is that that would cause a change in the stream profile.

Q All right. I shouldn't have used the term looked into. What I should properly have said, I expect, is that this wasn't assessed in the model that was created for looking at the stream?

A No.

Q And is that a problem which Unies has been asked to look into for Foothills?

A No.

Q And Mr. Mirosh, is that a problem which you see that should be looked into for Foothills?

WITNESS MIROSH:

A Well we don't intend to remove borrow from smaller streams, we have discussed the use of borrow from the mouths of some rivers where it may be suitable or from areas of the Mackenzie which are underwater and not bars. These are possibilities that if we implemented would alleviate our borrow requirements. We've also discussed removing spoil material from some of the major crossings and using

this for work pad. But as to smaller rivers and streams, we would not disturb the stream beds to remove borrow.

Q Could you define for me a smaller river, -- smaller than what?

A Well perhaps I'd go the other way around. WE have defined major rivers by a criteria of flow and width and these are the ones which we would consider, for possible borrow use at the mouths of these rivers.

Q All right. Now would you consider something the size of the Willow Lake River, a large river?

A Yes, that's one of the rivers which is defined as a large river by our definition.

Q All right, is it possible for you to give me the size in CFS or however you gauged it for what you define as a large river so I can get the idea?

A Yes, I think the formula was in the application but perhaps one of the Klohn Leonoff personnel recalls it.

WITNESS SPAFFORD:

A Yes, the way one defines a major river is quite controversial. We define it more on a point of view of difficulty of crossing the river and it may or may not have been influenced by the volume of flow. Our criteria were I believe in excess of 100 foot high banks, 30 percent grade or greater and 20,000 CFS design flow or greater, any one of these

factors would qualify it as major.

THE COMMISSIONER·

Q Thirty percent grade, what do you mean, the banks?

A Yes. Slope.

Q I can appreciate that, but I'm not quite sure how much closer it gets me to knowing which rivers you would contemplate taking granular material from the mouths or beds of. I can see how it fits in the formula in a sense but it may be that I could find a river that flows into the Mackenzie that had one of the characteristics of gradient or bank height and yet have a small flow and I'm assuming that you would have to make some sort of a judgment, not based on those two factors, regarding borrow.

WITNESS MIROSH·

A Perhaps we could prepare this list for the construction planning panel.

Q All right. I'd appreciate that if that could be done.

Now, referring, Mr. Spafford, to page 20 of your prepared evidence, question 46, you refer to the method of preparing your study of the rivers to include a check of the climatological and meteorological data that is presently available in the areas where these rivera are, is that correct?

WITNESS SPAFFORD:

A Sorry, I got lost on the first part of that question.

Q There were too many worda in it anyway. When you were setting up your system for

looking at the rivers, I gather you took a look at the weather statistics that existed.

A That's correct.

Q Can you tell us what sort of a state those statistics are in? Are they -- have they been recently compiled in some areas and not recently compiled in others?

A No, there are several major stations. I can't recall the locations of all of them, Fort Simpson is one. Fort Norman, Inuvik, all have weather stations with fairly long periods of record and these are filed by the Atmospheric Environment Service.

Q Now if we wanted to get more particular, and perhaps I can give you an example which again is one from the north slopes, it doesn't apply to Foothills, but as I understand the climate in the Firth and Malcom River Valleys are quite different even though they're fairly close together. Would the statistics show something like that?

A No, because there are no weather stations with any appreciable period of record up there. There's I think only one station on that part of the coast, and it's on the coast.

Q Would this be a condition, that could mirror the state of record, all the way up the valley. Are we in a situation where we've got several major stations, but there may be individual climatological and meteorological differences that don't get reflected in those statistics?

A Quite definitely yes. From one valley to another and especially in the mountainous areas.

Q All right, now given that, in order to use your criteria for design, would it be necessary to collect these data for individual stream areas, in order to pin down the conditions more exactly?

A For the type of thing we're doing we require an appreciable period of record so it's not possible to collect that data because it hasn't been collected.

Q I understand that you can't go back 100 years, nobody kept the records for then. Is there another way of going about it?

A Well, in this computation that we do, we do change the rainfall and temperature with elevation, so that -- and we do change it minerally between stations, so that to some extent, the effect of elevation is included but we can't put in things like aspect of a slope, relative to the storm tracks and that sort of thing.

Q These are things that you just have to be satisfied without because the records don't exist but there are various things you can do, one is height, is there something you can do to -- by looking at the vegetation to determine for example, the relative frequency of certain high flooding?

A That can give you possibly an indication of what extreme high flood levels were, or

what last year's flood level was.

Q This, as I understand it is not a very satisfactory method to go back for a long period of time, but it may go back for the generation of vegetation that's there, would that be fair?

A Well given a particular problem, one would look for that sort of thing. It's additional data to assist your judgment.

Q All right, you've described other methods for the large streams the flatter streams like the Mackenzie where you can bore into the alluvium and check for its depth, to determine the greatest depth of scour.

A That was with respect to depth of scour.

Q That wouldn't be something you could do for example, with a small stream with a--

A No, it wouldn't tell us anything about it hydrology.

Q Right. Now, perhaps this question should go to Mr. Mirosh. With regard to the problems of what happens downstream of where you run your pipeline across a river, has any work been done on that with regard to what happens to the sediments when they go downstream, what effect they have on the fish spawning beds and this sort of thing?

WITNESS MIROSH:

A You're asking me a question which I will have to answer by saying that I believe that the Lombard North group are working on it, but they

don't report these activities to me so I'm sure that the environmental panel will deal with that.

Q All right, will they be in a position to deal with that in your opinion. They will have completed some studies that will be able to give us some sort of opinion on that?

A Yes, I know they're concerned about sediment as it relates to aquatic life. I'm sure they are examining this.

Q Because I will submit to you that that is one of the things that you may have to consider when you're deciding how and where to cross a stream, would that be fair to say?

A Yes, or the timing, that's correct.

Q Now, if I could refer again, Mr. Spafford to page 20, question 45 -- 48, I'm sorry, you in your answer to that question described a situation where a pipeline is buried beneath the bed of the stream, and there are some conditions that I would like you to explain, which cause interruption of the flow, or a change in the flow due to the growth of a frost bulb or the fact that the pipeline creates a barrier to water flowing through the material deposited on the bottom of the stream.

Can you tell me just what that effect is, because I'm not clear whether the frost bulb is a good thing or a bad thing, from your answer.

WITNESS SPAFFORD:

A Well, as far as I can see at this point, if the frost bulb can develop, it means that the stream bed material is reasonably impermeable, and so what is being obstructed is a very slow rate of flow through the stream bed, and the obstructions -- by being obstructed, I simply mean it has to pass through a smaller area than it did under natural conditions, or else be forced up into the surface.

Q If that happens, that increases the velocity of the water, because it goes to a smaller amount of this material? Or it changes its route?

A Well, it changes its route, yes, and it may change the velocity, it may change the gradient driving it locally.

Q Right. Now what happens if you have a stream that in a year freezes to the bottom, so that the only flow would be through the granular material if there was any, and there's a pipeline buried in it. Do you end up with a stoppage of water and some sort of an icing, or what sort of a situation would you envisage happening under those conditions?

A Well I am envisaging at this point, but yes, you could create an icing, which will occur anywhere that subsurface flow is forced to the surface.

Q All right, and in terms of --

THE COMMISSIONER: Excuse me, you could create a what?

A An icing, this is the accumulation of ice from ground water discharge.

MR. BAYLY:

Q Now, would this icing be something that in your opinion might have some effect on the integrity of the pipeline?

A I don't think I can answer that question very well, because the actual pipeline design and problems haven't been in my field at all.

Q All right. I take it then that you would not be the person that Foothills would ask about whether you should bury it six feet deep because of that, or whether you should leave it

six feet higher up?

A In the type of service I have given them so far, I would be the person they would ask whether there could be an icing or not.

Q All right.

Mr. Mirosh, assume Mr. Spafford has just told you there's going to be an icing the way you have designed the stream crossing, do you bury it deeper or what do you do?

WITNESS MIROSH:

A Well I suppose we would have to, first of all try to determine what effect this would have on either the pipeline or the environment. If it was a negative effect, then burying it deeper would be one solution.

Q All right, would there be any solution that would involve changing the composition of the material that was put on top of the pipe, making it perhaps less permeable?

A Perhaps.

Q And would this be something that you would anticipate leaving 'til final design, or would you be looking at that before that time, that sort of phenomena?

A Well that phenomenon is one that we planned to study with the geothermal model, and it will be carried out. It is in our plans, that's one of the very reasons we are introducing the moisture migration element.

Q All right. Would this be

something that we would have the benefit of during this Inquiry, in your opinion?

A Well yes, I suspect if the Inquiry continues as it is predicted.

Q All right, maybe I should put that another way, Mr. Mirosh. When would this be ready?

A Well I think Dr. Hwang said earlier that he's very close to utilizing the completed model, that being the case I would suspect within a month or so.

Q All right, now when you say utilizing the model Dr. Hwang, that means that you would start to be able to study these things, or you would have studied them within that period of time?

WITNESS HWANG:

A Well --

Q Yes, you will probably need the microphone, yes.

A Could you repeat the question, please?

Q Yes. Mr. Mirosh has said that within a month or so you will have your geothermal model ready, and I was asking you whether that means that you will be ready to draw conclusions from it or ready to use it?

A I would say at that time I will be ready to analyze it, considering flow characteristics and the possible material we are going to use, and from there, we come to the conclusions, or

some estimate.

Q So sometime after a month from now, we will be able to have the benefit of some kind of a report from you on this, would that be fair to say?

A I will try my best.

MR. BAYLY: Mr. Commissioner, perhaps we could have the benefit of that report from Foothills as soon as it's available.

Q Now one of the matters that is of concern to me and that is, Mr. Spafford, in your E.P.B. report, you were worried about borrow, not only from the streams but from the flood plains of streams, and one of the things that Mr. -- can you confirm that, that was one of the concerns you had expressed in that report? I think I can find that for you.

I can't find that at the moment, but would you be prepared to agree with me that borrowing from the flood plain may present some problems that are similar to those of borrowing from the river bed itself?

WITNESS SPAFFORD:

A They are not necessarily similar. Borrow could be made from the flood plain conceivably without causing any change in the stream profile, which was the concern of borrowing from the stream bed. The danger would be that you would cause a diversion of the channel.

Q I see, and --

A And into some new part of the flood plain.

Q Yes, and I think I found that and can refer to it for the purpose of the record, that's page 185, the final conclusions, talking about the importance of the flood channels to local aquatic environments as being a possible effect.

Now, given that as a concern of Mr. Spafford wearing another hat, Mr. Mirosh, what are your thoughts on borrowing from the flood plains of streams, if that should be a consideration that Foothills would want to make?

WITNESS MIROSH:

A Well I think in our discussions so far we have decided that this would not be a location of borrow.

Q All right. Now, can I take it then that we are only looking at borrow actually from the mouths of certain streams, perhaps from certain streams that are greater than a size that you will be able to give us at the time of the construction panel, or borrow from the bed of the Mackenzie River itself? That is, as it relates to streams, you may want to borrow from gravel pits that have nothing to do with water drainage.

A Yes, of course our plans are based on borrow material from gravel pits. But yes, I would agree with your items.

Q All right, and those would be the recommendations you would be making to

Foothills when they were looking for places to borrow, to get borrow material?

A Yes, these are the ones we have discussed, we would consider.

Q Now one more question with regard to ground water discharge, and if we can refer again to the E.P.B. report at page 197. Mr. Spafford, you have stated in the second column in that, that only the Great Bear River, and the exit, I presume from the Great Slave Lakes has a gauging station that operate in the winter. Has that situation changed since the writing of this report, or do you know the answer to that?

WITNESS SPAFFORD·

A I don't know the answer to that.

Q All right, at that time anyway, there would only be two where winter flow could be gauged.

A Apparently, yes.

Q And I gather the beginning of the Mackenzie coming out of the Great Slave Lake.

A I think there is, the recent records on other streams have been extended through the winter in some instances but I don't know which ones.

Q All right. Mr. Mirosh, are you acquainted with any data that Foothills has on the winter flow of any rivers other than the ones mentioned in the EPB report?

WITNESS MIROSH:

A No sir, we have depended on Unies and some data from Klohn Leonoff on that.

Q All right. Do you plan to do any studies in this area to determine winter flows in actual streams?

A Yes, these are things we'll have to do, again, at a stage which we've gotten to call final design.

Q Now given that you would leave these till final design, is it possible to do these and perhaps Mr. Spafford can answer this, is it possible to look into the stream flow in the winter, with

a single season of gauging with any accuracy or would you require more than one season in your estimation?

WITNESS SPAFFORD:

A One season would give a reasonbly good idea of what streams do flow in winter but not necessarily all because there are streams that dry up some winters and not others.

MR. BAYLY: I have no further questions of this panel, thank you sir, gentlemen.

THE COMMISSIONER: We'll take a five minute break then.

(PROCEEDINGS ADJOURNED FOR FIVE MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

CROSS-EXAMINATION BY MR. MARSHALL CONTINUED:

Q Mr Claridge, in response to a question of Mr. Bayly's I believe you indicated that the slope studies were aimed at defining a route corridor. What do you mean by a route corridor, what width?

WITNESS CLARIDGE:

A Well we can't be specific on that but I indicated that we were examining slopes routinely five miles either side of the proposed route, so you might say it's a ten mile corridor that we have been examining.

Q That's a pretty wide area, doesn't it in some places take you right across the Mackenzie River from the proposed route?

A We managed to get across the Mackenzie but just let's say out of interest more than anything. I would say we were generally bound by

the east side of the Mackenzie, that's true.

Q It wasn't clear to me whether you had said something earlier on in answer to one of my questions, I'll just go back over it with you again to see if I've got it right. Did you say that Foothills had not made a firm decision on the last point of chilling and that it might be running a hot line or a line that was above freezing around the Ebbutt Hills?

A Yes, that is a possibility, there has been no decision on that matter and it will pend further studies and I would say it's another question that would be settled during final design, when all of the information is in, that decision will be made.

Q Sir, could you get before you the Klohn Leonoff's consultants reports application of Float Stability Analysis.. to design Foothills Pipelines Limited.

A I have that.

Q This was your report as I understand it?

A I worked on it.

Q You signed it?

A I signed the letter. It was reviewed by others.

Q Signing the letter is fine, as far as I'm concerned sir. Now, the first point is, on page six, the second line and you make this statement. The process of poor pressure development

due to thawing of ice and the related migration of water is not well understood. Have you found that reference sir?

A Yes.

Q Could you tell me Mr. Claridge what it is that is not understood?

A The process of poor pressure development, that's related to factors such as disturbance, the makeup of ground ice, the type of soil, all of these things are factors and there's no well documented theory for predicting this type of development.

Q Well are you aware of papers Number 19, 20 and 37 that are referenced at page 3B-2.54 and 55 of the Foothills application. I'm instructed that these are a theoretical assessment of the problem by consultants to Arctic Gas. The references I've given you are to pages in the Foothills application.

A Yes, I'm aware of this.

Q And did you not accept that these are a theoretical assessment of the problem?

A They are theories, however, they have not been proven.

Q Are you familiar sir with a paper by Sykes et all, it's reference Number 13, page 3B-2.53 which is a separate study and which arrives at essentially identical conclusions?

A Can you refer that -- where are you reading from these -- which reference?

Q The reference is item Number 13 listed at page 3B-2.53 of the Foothills material. The Foothills application.

It's the Foothills application, it's with the black cover, I write the numbers on it and they never show up. I'm not sure what the exhibit number is.

Mr. Mirosh has found it?

A Yes

I'm not personally familiar with that.

Q I see.

Are you aware of where two papers by Morgenstern and Nixon, which provide test data and laboratory testing in an actual full scale field trial that provided experiemental verification of the theory?

A Yes, I've read those papers I think, which numbers are they in here?

Q They're not listed sir, but my advisors have copies of them.

A Can you give me the exact reference?

Q "An Analysis of the Performance of a Warm Oil Pipeline in Permafrost Inuvik, Northwest Territories," by Morgenstern and Nixon. It's in the Canadian Geotechnical Journal, Volume 12, 1975, starting at page 199. The second

paper is entitled "Thaw Consolidation Tests on Undisturbed Fine Grain Permafrost" by Nixon and Morgenstern. That is the same journal and it starts at page 202.

A I'm not familiar with those.

Q I see.

Q Well my instructions are, sir, that these reports provide test data on laboratory testing on an actual full-scale field trial to provide an experimental verification of the theory?

A This may be true at that point, however, we are dealing with quite a long pipeline route and I think one would have to do considerable testing and it would still not be confirmed until one had actually checked it against a good number of field situations.

We do not disagree with the use of the theory at all --

Q Well it would be difficult to --

A -- however, it is a case at this point we have chosen to emphasize field conditions, route selection, gathering of actual data and we choose as a second line to check, let's say, what we have done through a theoretical approach. This will be done but we feel it's a second line of defence, and it would be done at a final design level.

Q Well sir, I don't really know how you can say that when you haven't read the literature that deals with this precise point.

A I understand the papers that precede those particular ones, and I think I can anticipate the type of information that is in it. I am not disagreeing with it, obviously I haven't seen it, but I think it's a continuation of previous papers that the authors -- they have written a good number of

papers, so I have an anticipation on what would be in them.

MR. MARSHALL: Mr. Commissioner, just for the information of the Inquiry, a field trial was undertaken by Mackenzie Valley Pipeline Research Limited at Inuvik, and that's what the papers pertain to.

A These I believe are fairly well known tests. There have been other papers written on them.

Q What other papers have been written on these tests?

A I could find out, I don't have it on the top of my head.

Q Well do you know about them?

A Dr. George Watson I think has been involved for instance on several of those papers.

Q Have you read them?

A Not last night or last week, but I have read them, yes.

Q And these are other papers that deal with the same process and the same tests, are they?

A Yes, I believe that would be the test, the warm oil test facility in Inuvik conducted some some years ago.

Q And your study of these other papers has still left you unconvinced that the

process is well under study?

A I think there would be doubts in its application. I think they can be used and they will be used, but it's not our first line of attack on the problem.

Q Well sir, I would be happy to make copies of these available for you if you care to review them.

A I would be very grateful.

Q Sir, also in the line following that which I first quoted to you in your own report, the following statement is made: "It is considered that permeability of the soil is a key parameter". Have you found that?

A M'hmm.

Q Sir, could you tell me what other parameters may govern?

A Yes, when one analyzes the slope, there are -- I don't want to bore the people here with all of the items that are involved, pore pressure is a key parameter, cohesion is another, friction angle, unit weight. If one is looking at pore pressure development, there would be thermal coefficients, thermal conductivity. I think we have described what's involved in other parts of our application and this report.

Q Sir, what about the coefficient of consolidation, the old friend of the Inquiry, C sub V? Don't these theoretical discussions just reference all states of prime importance of this?

A We have not used the theory wherein the co-efficient of consolidation CV is referred to, because we do not believe it is a parameter that can be adequately determined, that the results that one obtains may be in error by large amounts that would be very, very serious to one's interpretation.

Q Sir, whose opinion is that? Is that your own?

A That's my own, and I have seen it expressed elsewhere.

Q Well perhaps you could give me those references.

A There is a discussion of the use of the co-efficient of consolidation in the pipeline application assessment report. I agree with that assessment.

Q Dr. Hwang, were you involved in a review of the Alyeska designs?

WITNESS HWANG:

A Yes, I did.

Q Yes, I think there is something in your resume about that, is there not?

A Yes.

Q And to your knowledge, sir, were Alyeska's permits to proceed subject to delays because their slope stability designs in thawing soils were based only on permeability and not the co-efficient of consolidation?

A You cannot deal in such

a specific area, but I understand they were asked to supplement more parameters, and obviously the CV, the co-efficient of consolidation is a soil behaviour which describes the rate of pore pressure dissipation.

Q And to your knowledge, were their designs reformulated in terms of C sub V?

A I have to -- could you repeat that again, please?

Q Well to your knowledge, sir, did the Alyeska reformulate their designs in terms of this parameter, C sub V?

A Yes, they used that one as a parameter to represent soil consolidation.

WITNESS CLARIDGE:

A I would like to perhaps add a comment. I too have some information on the approach that is being used on the Alaska Pipeline, which is privileged information I have through personal contact, I can't give you a report on it or anything, but I have been told that the approach there using C sub V is doubtful.

THE COMMISSIONER: Is what?

A Is doubtful in its application to real field conditions. I might repeat again that we feel we are doing what is important at this time, and that is studying field examples of slopes, and any slope, whether it's in permafrost or other terrain, it is very, very difficult to assess in terms of a safety factor, or a number, what is the exact number of a present unfailed slope, even in ideal

terrains, and it is that much more difficult in frozen ground, and the theory may exist and it sounds very fancy, but we frankly do not have our confidence that it is of any practical value to us now.

MR. MARSHALL:

Q Well sir --

THE COMMISSIONER: You say that in Alaska the builders of the Alaska pipeline, are not confident that the principle expressed in C sub V is applicable?

A I didn't say the builders.

THE COMMISSIONER: The engineers?

A My own contacts are with a review team that is reviewing the job, and I'm sure they are more critical than the builders of the pipeline, in fact that was their comment.

I remember a quotation the applicability was questioned.

MR. MARSHALL:

Q Well sir, there are a couple of things that arise out of that. The first is that I think clearly when the witness has a report which he's implied, that he is using as the foundation of an opinion that he's expressed, and by using it he has taken away or removed any claim that that might be a privileged document. This is the substance of the statement that he is making, or the authority for a statement, I think we are entitled to get a copy of that report.

THE COMMISSIONER: Well did you say that this was a personal contact you had on the Review Board? I take it it's an engineering review board?

A It's an engineering company that is performing as a review consultant --

THE COMMISSIONER: Yes.

A -- to the Alaska Pipeline office. And it was personal communication, there is no report, sir.

Well he doesn't have possession of the report.

MR. MARSHALL:

Q I see. Well Dr. Hwang, you were on the Review Board, weren't you?

WITNESS HWANG:

A Yes, I was. Could I comment on this a little bit? I think what Mr. Claridge say is not invalid of the theory, but rather saying that the experimental determination of the C sub V in the lab as compared with field conditions, sometimes the variation because of the field conditions like ice and the other characteristics may find out that C sub V actually happened in the field , is different somewhat from the lab.

THE COMMISSIONER: Just so I follow you. This theory which I understand to be a conventional engineering theory, has not proved in Alaska to be applicable to the extent it was thought it

would be, because of the presence of ice. Is that what you have just said to me?

A The theory itself, according to engineering principle is sound but the parameter involved with what actually happens in the field, may be buried in such a way that when we come to the analysis of slope stability, it may give you a bound to understand but actual number may be buried.

Q They give you a what?

A A bound, a feeling A feeling of the number. For example, like a certain slope being thawed at a certain rate, if we use the C sub V determined from the soil data we may find out the slope will have a factor of 70 in order 1. That is on the verge of failure but actually the slope was standing there, so it may be because the C sub V in the field when the ice is melted and is seeping through the ice, the seam in the soil will actually have a higher permeability than you measure in the lab and therefore your C sub V will become higher and therefore your factor of 70 will be higher also. It is a field condition against the theoretical prediction.

THE COMMISSIONER: Excuse me, I think we'll adjourn in a minute and you can go into this in the morning.

MR. MARSHALL: Fine sir.

THE COMMISSIONER: You wanted to add something before we adjourned?

MR. CLARIDGE: I had one more point.

THE COMMISSIONER: Forgive me I'm terribly slow, but do you want to restate in your own way what Dr. Hwang just said or do you agree with him?

A Yes, I agree with Dr.

Hwang and I wanted to add just one small point.

THE COMMISSIONER: How would you express what he said?

A Our philosophy as in Klohn Leonoff's report is we place emphasis on the observation of pore pressure. Pore pressure is a factor in slope stability. We propose to basically observe what are the pore pressures. this is the direct parameter and we would emphasize a good deal, field observations, we've said that. The famous co-efficient CV is another parameter which is one step down the road really. It contains an equation, it is an equation which contains the term permeability. But it has another nasty term in it and the method that is used in determining it is a lab one which because of the way the sample is tested, the CV value and the permeability that is deduced from that can be out by a large magnitude. In other words, you're trying to get at the same thing that we've said we are trying to get at, is pore pressure, and it's related to permeability, it's related to other factors, Arctic Gas say they get it in the lab. we say we get it party by measuring it directly in the field, party in the lab, that we measure real values, not ones that we deduced through tests and theories that we regard are not accurate. The same coefficient is used it shows up in prediction of settlement in consolidation, it's well known in the field that measurements of that co-efficient in certain soils in the laboratory can put a settlement calculation out by a factor of up to five or ten times.

I submit if you were out on our prediction of pore pressure, by a factor of five or ten times then you would over predict it, you would estimate slope would fail at a much lower angle than they really do. Now what this might have, as an implication for the pipeline is that if you thought a slope was going to fail at much less angle than it really does, you would be out all over the countryside repairing them. This I don't submit is a good idea from an environmental viewpoint. This is what bothers me about the use of that theory.

THE COMMISSIONER: I think Mr. Marshall will want to go into this with you in the morning and you might with to confer with Dr. Clark in any event now, so we'll adjourn until tomorrow morning at 9:00.

MR. GENEST: Perhaps I should get back on the record Mr. Commissioner to say it feels like I've never been away.

THE COMMISSIONER: You heard we were discussing C sub V Mr. Genest. I thought that would bring you back. You can explain it to us in the morning.

(PROCEEDINGS ADJOURNED TO SEPTEMBER 19, 1975 AT 9:00 A.M.)

MACKENZIE VALLEY PIPELINE INQUIRY

IN THE MATTTER OF APPLICATIONS BY EACH OF
(a) CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES; and
(b) FOOTHILLS PIPE LINES LTD. FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE NORTHWEST TERRITORIES,
FOR THE PURPOSE OF A PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINES

(Before the Honourable Mr. Justice Berger, Commissioner)

Yellowknife, N.W.T.
September 19th, 1975

PROCEEDINGS AT INQUIRY

Volume 65

ALLWEST REPORTING LTD.
4[illegible] CANADA WAY
BURNABY 2, B.C.

APPEARANCES:

Mr. Ian G. Scott, Q.C. Mr. Stephen T. Goudge, Mr. Alick Ryder and Mr. Ian Roland	for Mackenzie Valley Pipeline Inquiry;
Mr. Pierre Genest, Q.C. Mr. Jack Marshall, Mr. Darryl Carter,	for Canadian Arctic Gas Pipeline Limited;
Mr. Reginald Gibbs, Q.C. Mr. Alan Hollingworth	for Foothills Pipelines Ltd.;
Mr. Russell Anthony, Prof. Alastair Lucas	for Canadian Arctic Resources Committee;
Mr. Glen W. Bell and Mr. Gerry Sutton	for Northwest Territories Indian Brotherhood and Metis Association of the Northwest Territories;
Ms. Leslie Lane	for Inuit Tapirisat of Canada and the Committee for Original Peoples' Entitlement;
Mr. Ron Veale and Mr. Allen Lueck	for Yukon Native Brotherhood;
Mr. Carson H. Templeton	for Environment Protection Board;
Mr. David Reesor	for Northwest Territories Association of Municipalities
Mr. Murray Sigler	for Northwest Territories Chamber of Commerce

INDEX OF WITNESSES

WITNESSES FOR FOOTHILLS PIPE LINES LTD.

PANEL 9 - PHASE 1

PANEL 10 - PHASE 1

INDEX OF EXHIBITS

Yellowknife, N.W.T.

September 19th, 1975.

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

THE COMMISSIONER: Whenever you are ready, Mr. Marshall.

MR. MARSHALL: Yes sir.

GORDON SPAFFORD, Resumed:

FREDERIC CLARIDGE, Resumed:

FRANCIS YIP, Resumed:

C.T. HWANG, Resumed:

EDWARD MIROSH, Resumed:

DON DAVISON, Resumed:

CROSS-EXAMINATION BY MR. MARSHALL, CONTINUED:

Q Dr. Hwang?

WITNESS HWANG:

A Yes?

Q I take it that you would have read in the past, the literature pertaining to thaw consolidation?

A Yes.

Q Which is where the parameter C sub V is applied?

A C sub V is the parameter representing the soil property, which in a simple form, to explain it, is describing the rate of pore pressure

dissipation.

Q Right, and you have read this literature?

A Yes, I did.

Q And that would include those papers that I referred Mr. Claridge to, and which he hadn't, at that time, had an opportunity to read, being papers by Drs. Morgenstern and Nixon ?

A Yes.

Q The first was Thaw Consolidation Tests On Undisturbed Fine-grained Permafrost, and An Analysis of the Performance of a Warm Oil Pipeline in Permafrost, Inuvik, Northwest Territories?

A That's right.

Q You are familiar with those papers?

A Yes, I am.

Q Did you agree with the findings presented in those papers, sir?

A Yes.

Q Sir, perhaps just for purposes of completion, these documents we have been talking about, ought to go in as part of the record.

THE COMMISSIONER: Yes, I think they should. They will be marked as exhibits.

(PAPER: J.F. NIXON AND N.R. MORGENSTERN; THAW CONSOLIDATION TESTS ON UNDISTURBED FINE-GRAINED PERMAFROST MARKED AS EXHIBIT 256)

(PAPER: N.R. MORGENSTERN AND J.F. NIXON; AN ANALYSUS OF THE PERFORMANCE OF A WARM-OIL PIPELINE IN PERMAFRAOST, INUVIK, N.W.T. MARKED AS EXHIBIT NUMBER 257)

MR. MARSHALL:

Q Mr. Claridge, I don't want to put you on the spot, and I know you told us last night that you hadn't had an opportunity to read them. Perhaps you could study the two papers that are just being marked as exhibits, and in due course, and there is no particular hurry about it, you could advise us through counsel whether or not you too agree with the papers?

WITNESS CLARIDGE:

A Certainly.

Q Mr. Claridge, when you discuss stabilization measures in your report, you indicate that you are proposing to Foothills Pipe Line that they flatten the slope by cutting it back, that is, removing earth from the top and perhaps placing it on the bottom. I think the reference is at or about page 25.

A That's correct.

Q I was wondering, sir, if you considered this to be an acceptable slope stabilization procedure for permafrost terrain?

A In what I would term as thaw, unstable permafrost terrain, this may not be an acceptable universal treatment. We would prefer to avoid disruption of the slope as much as possible. We think we can do so by route location procedures.

Q I take it then that essentially you're in agreement with the position that Arctic Gas' advisors take on this point?

A I believe so.

Q That's stated in the exhibits.

MR. HOLLINGWORTH: Are these the exhibits you just asked him to read, sir?

MR. MARSHALL: I'm sorry, I should have used the term application. They are stated in the Arctic Gas application.

A Yes, I believe that is right.

Q Do I take it, Mr. Claridge, that in the case where your analysis indicates a factor of safety of less than 1.0 under dynamic loading, you may very well then recommend to Foothills that they cut back the slope to an angle which you would calculate to have at least a factor of safety of 1.0?

A The word dynamic should really have read "seismic". This could be the case, but it would depend on the site specific parameters.

Q I see, so there's just a small error there. It should be a word change in the report, should it?

A Yes, the word "dynamic" should read "seismic".

Q Do you not agree that what you will be doing, if you do this, is exchanging an environmental reality to satisfy a statistical risk? So I understand it that it would mean that a slope that is standing naturally and has been that way for thousands

of years, may be cut back to a flat angle to satisfy an analysis based on the statistical risk?

A We do not use statistics as such in the analysis of our slopes.

Q How do you input your seismic data?

A This would be done through a procedure which I'm sure we shall be able to refine by the final design time. There are methods of incorporating seismic factors, based on seismic records in the area.

Q Aren't those records the statistics that we are referring to?

A In a manner of speaking. I interpreted your statement of statistics to indicate a statistical approach to doing slope stability which in that context I would not subscribe to.

Q Do I take it that in any event you haven't really determined the method that is going to be used?

A We have not refined the method as such. Again, I reiterate our position is one of going to the field, collecting slope data from which we can select a route location that avoids, as much as possible, disruption of slopes and the final design where it becomes necessary to check the stability of any suspect slopes. We will be collecting the site specific data to permit us to do that.

At this time we have not worked out, in full detail, the exact design approach, because

it is not a matter that we consider critical at this time.

Q The point I am getting at is that if you are going to cut back those slopes where you have made an analysis that tells you the slope will have a computed factor of safety of less than 1.0 under dynamic loading --

A No, that's not correct.

Q You're not going to do that?

A If I read from the report, it says a steep portion of the -- I'm on the wrong page, what page are you on there?

Q Well I'm just putting a question actually, I was halfway through it. Perhaps I should start again.

A I take it you're reading from a particular example.

Q I'm actually reading from some notes.

A I believe you're referring to the statement that says a steep portion of the north slope may require cutting to ensure continuous stability. The word may indicates that we may do it or we may not, depending on the site specific circumstances, which we haven't evaluated.

Q Could you look at page 8. The sentence is in the paragraph at the top of the page and it's the last sentence, I'll read it. Or the second last sentence. "The minumum factor of safety which is considered to acceptable under static loading conditions is 1.25 and 1.0 under dynamic loading conditions. Variations from these values will be considered, depending on the specific site conditions."

A Yes, I think that statement is referring as much to a location where cut slope would be necessary more than a natural slope. Some cuts will be needed and we would not design a cut to lessen those

levels. The natural slope, as indicated yesterday, we would follow essentially a field procedure initially and our second attack would be an analytical one, but we place less credence on that.

Q This is getting a little beyond my depth.

Mr. Claridge, I'm sorry for the difficulty I'm having with you on this point. I just want to make it clear whether or not you disagree with the Arctic Gas advisors about this, and is it your intent to recommend to Foothills that they stabilize slopes where the dynamic loading is equal to or less than one?

A Repeat the wording please.

Q Is it your intent to recommend to Foothills that they stabilize slopes where the dynamic loading is equal to or less than one? Where a factor of safety, under dynamic loading is equal to or less than one.

A I might point out that seismic loading, as such, is not a really significant factor in our route. The seismic risk is small, the effective earthquakes in seismic loads is very slight. Therefore, we feel we would go to a minimum factor of safety, such as one, but what I'm getting at is that we would refine our approach to that because we're aware that under a basically static equilibrium analysis, that a slope may fail at a factor safety of one, but it may not in fact damage the pipeline. There may be a movement and we would work towards incorporating the movement

criterion in our analysis, but because of the low risks involved, we have not considered it necessary to delve into that at this moment. It's something that would be done later.

Q I'm sorry, I didn't want to interrupt you before you finished your answer, but it seems to me you didn't really answer my question. It was, I think, capable of a yes or no answer.

Would you mind giving me an answer to whether or not that is your intent or it is not your intent?

A I think I gave you the philosophy behind how we would do an analysis. I don't think it really boils down to a very succinct answer such as you're implying.

Q Well if I asked you whether or not you intended to make a particular recommendation to Foothills or you do not and you're not able to give me a yes or no answer?

A We would not give a yes or no answer to Foothills on such an important subject.

Q Well, there we are, wherever that is.

Mr. Claridge, by reading page 11 of your report, my advisors have concluded that your procedure for cutting slopes will result in slopes in thaw stable soils, i.e. unfrozen soils or frozen soils of a low ice content, being cut back to a much flatter angle than soils with medium to high ice contents, which you contend may be cut near vertical. Would you care to comment

on that?

A Yes, this is an area that is controversial in the profession. We have been examining the procedures in use on the Trans Alaska Pipeline and we've given it some thought ourselves. We do not undertake to make a commitment obviously at this time without further site specific knowledge, but our attitude at this time is that we would consider steep cuts in certain types of ice rich soils such as random or wedge ice content but where other types of ice are present, we would consider that flatter slopes are going to be preferable.

Q Do I take it that you don't differ from the Advisors to Arctic Gas in this respect.

A I recall reading a passage that I would agree with in Arctic Gas, yes.

Q Mr. Spafford, could you tell us something about you experience in river engineering as distinct from hydrology?

WITNESS SPAFFORD:

A Well, without getting specific, I think perhaps it's fairly well outlined in my summary of experience, which is to the effect that I worked on the design of a variety of structures, in rivers and have worked on highway stream crossings, and items like that.

Q Fine, thank you sir, I appreciate your going over that.

When did you commence your work for Foothills?

A In January this year.

Q I understand from answers you gave to Mr. Bayly, that you have not done field work in connection with this assignment for Foothills?

A No sir.

Q And it would follow then, I suppose, that you don't have soundings? For the stream crossings that you have produced?

A There were soundings for the east channel crossing in the vicinity of Swirring Point, and there were soundings also for the Naylor's Landing crossing of the type used for navigation.

Q Are those soundings in your reports?

A No they are not.

Q I see. Well perhaps we might be provided with copies of those.

A Fine, I don't have copies of them now with material provided by Foothills, it is for the execution of my work.

Q I see, thank you.

Mr. Hollingworth, might we have those?

MR. HOLLINGWORTH: I think Mr. Spafford said the soundings were provided by Foothills?

A Yes.

MR. HOLLINGWORTH: Do you know where those soundings came from in the first place?

A The ones for Naylor's Landing came from the navigation charts for the Mackenzie River, and those are published by the Department of Transport, I believe.

MR. MARSHALL: I don't think we want those.

A The other ones, I'm afraid I don't remember the source. It is a map of soundings at a scale of, as I recall, a hundred feet to the inch, with five foot contour soundings on it, and it was prepared by some organization whose name I don't remember.

I can find that out, but I'm afraid I can't help you right now.

Q Okay, well if we could be provided with this information I would appreciate it, Mr. Spafford.

I want to deal with your report on scour in the east channel of the Mackenzie River below Tununuk Point of February, 1975, and you have a copy of that before you?

A Yes, sir.

Q Now, do I understand correctly from the first paragraph, that at that time two routes were under investigation, one crossing the Mackenzie two miles below Tununuk Point on the southern tip of Richards Island, and the other 12 miles further

downstream near the mouth of Holmes Creek?

A That's correct.

Q And at the latter, an alternative was under consideration immediately upstream of Holmes Creek, and one about one-half a mile downstream of Holmes Creek?

A Yes sir, that was my understanding at the time.

Q And Mr. Mirosh, I take it that Foothills selected their crossing, the single crossing of the east channel off the Mackenzie, at the location which is shown in the alignment sheets that are filed with the Foothills' application?

WITNESS MIROSH:

A Yes.

Q And that's the location immediately upstream of Holmes Creek?

A Yes.

Q And that's shown on the alignment sheet drawings 0200-03, I believe?

Perhaps you could -- you have that available in front of you, do you? If you accept that that's where the drawing is shown -- just check that.

A 0200-03.

Q Right and this is Foothills' choice as to the crossing site for this location? That hasn't been changed?

A That was the -- well it still is the choice, but was the choice at the time, but

used by your panel, perhaps we could check the transcript on that if there is any doubt in your mind or Mr. Hollingworth's. You accept that?

A I recall using those numbers. I hope they are consistent with the numbers in the report. I suspect they are.

Q Okay, Dr. Clark informs me that they are consistent with the numbers used in the report, and you've confirmed that you used them, so I guess we are together at this point.

THE COMMISSIONER: Ad idem, as we say.

MR. MARSHALL: Ad idem. Well, we lawyers don't like to throw out those complicated legal phrases sir, it might confuse the engineers.

THE COMMISSIONER: We have to have some means of fighting back, don't we?

MR. MARSHALL: I think we are really going to have to do better than that.

Q Mr. Mirosh, I understand from looking at that alignment sheet that I referred you to and which you have in front of you, that the crossing that you have selected is the shortest one?

A Yes, I believe that's the original CAGPL crossing which we have so far taken to be the one we have on our alignment sheet, yes.

Q Well sir, as I understand it, the Arctic Gas crossing location is about a thousand feet upstream of where Foothills proposes to cross.

A I see. I'm advised during

a winter reconnaissance, there was an adjustment made from the CAGPL crossing.

Q My instructions are, sir, that the Arctic Gas crossing at this location is about a thousand feet upstream of where Foothills proposes to cross, and that's the location that was shown in the application and that hasn't been changed. It was determined in 1973.

A Yes, as I say, there was an adjustment made to the original CAGPL crossing which is shown on this alignment sheet.

Q Well sir, perhaps it was a Foothills adjustment.

A Yes.

Q I see. The point being that there is somewhat of a constriction in the east channel of the Mackenzie, in the vicinity of these two crossings, and Foothills proposes to cross at the point where this constriction protrudes into the river, and hence the distance from bank to bank in that area is the shortest. Arctic Gas' proposed crossing is upstream of that, and the river is somewhat wider at that point. Is that so?

A Well I don't have the Arctic Gas alignment sheet here, but I take that as being so.

Q Sir, was the Foothills crossing at this point chosen on the basis that this was the shortest distance across the river, this was the best place to cross for that reason?

A I expect when this was done, that was probably the reason, yes.

Q Well sir, perhaps you could look at the Unies Report on scour in the east channel of the Mackenzie River below Tununuk Point, February 1975. Mr. Spafford I'm sure has a copy of it. This report deals with the crossing of the east channel of Foothills does it not?

A This report deals with a study of scour in the vicinity of that crossing.

Q Yes, well Mr. Spafford has indicated

THE COMMISSIONER: Would you point out that crossing on your map.

MR.MARSHALL: Sir, we have the Foothills alignment sheet if you'd like it.

THE COMMISSIONER: Pardon me?

MR MARSHALL: We have the Foothills alignment sheet if you'd like to see from the alignment sheet where the crossing is, it might be useful.

A The crossing we're discussing is the Mackenzie East Channel of Mile Post 23, this location.

THE COMMISSIONER: I'm with you.

MR. MARSHALL: Mr. Commissioner, we have the Foothills alignment sheet which shows this particular crossing.

THE COMMISSIONER: Well, I'd like to see that too, but that crossing always causes

me difficulty, that's where the Parsons Lake -- that's where the Richards Island line crosses the east channel onto the mainland essentially, is that a fair way to put it.

A Excuse me sir.

Q That crossing is where the -- where you come from Richards Island to the mainland?

A Yes, that's correct.

THE COMMISSIONER: Yes, all right.

MR. MARSHALL:

Q Sir, the Foothills crossing location is shown there just upstream of Holmes Creek and the point I was directing Mr. Mirosh's attention to is that there is a bit of a constriction at the -- of the channel at that point and the point where Foothills crosses is the shortest distance across the river in that area?

THE COMMISSIONER: Did you say that was where the Arctic Gas Crossing is.

Q No, that's where the Foothills crossing is. The Arctic Gas crossing is about a thousand feet upstream of that location. They propose a dual crossing there and the other prong of the dual crossing, the other line of the dual crossing, is about a river width downstream of the one I first described, so the Foothills crossing is somewhere in the middle of the two proposed by Arctic Gas.

Well sir, dealing with the Unies Report, on these channels the passage I want to refer you to 'refer you to is on page eight

and I'll read it in.

"However, ample allowance should be made for the crudeness of the analysis and the lack of relevant data for design, therefore preliminary pipeline design should allow for a scour depth of 20 to 25 feet below the present stream bed, at the pipeline crossing."

A Yes.

Q Have you found that sir?

A Yes, I see it.

Q It goes on to say this in the next paragraph, "For the analysis described above, a straight uniform reach of the channel is assumed. This applies reasonably well to the proposed crossing location some 5,000 feet downstream of the mouth of Holmes Creek, but not to the site immediately above Holmes Creek where it is probable that proximity to channel irregularities causes a concentration of flow and a local increase in gradient. This condition is caused by bends and obstructions at several locations along the east channel and it may be anticipated that these locations will be the first to scour and will experience deeper scours in other parts of the channel bed. Evidence of this is the depression in the stream bed immediately upstream of Holmes Creek." You're familiar with that?

A Yes, I think that's very good advice.

Q Well sir isn't it true that of the alternatives that were considered for a

crossing, you chose the shortest one, thus putting the line in a more hazardous location, and at point where your consultant advised you that the scour conditions were worse than the alternative location, and may well in fact exceed that value which you cited as your example of a properly designed single crossing.

A Yes, one of the reasons for looking at an alternate is this consultants report and others.

Q Well you had the consultants report in February, sir.

A Yes.

Q And even so, you chose in your filing in May to select a crossing which seems to be at the worst location?

A It shows how we would handle the situation at this location, that's correct.

Q I find that to be an interesting approach and perhaps we can get into that a little but further. I have some drawings that I'd like to refer you to sir and these are taken from a report that was prepared for Northern Engineering by T. Blench and Associates entitled "River Morthology Data and River Engineering Design, Major River Crossings North of the 60th Parallel". Now sir, that is a report that has been included in the lists of Arctic Gas and I believe Foothills has this report in its possession. In fact, as I understand it, it's an update of an earlier report that was done in 1973 and Alberta Gas Trunk Lines would have obtained that as part of its

membership in the study group.

The drawings I'll identify, one is Proposed Design, Mackenzie River at Swimming Point, T. Blench and Associates Limited, dated February, 1973; the second is Index Mosaic. Mackenzie River at Swimming Point, T. Blench and Associates, March, 1973 and the third is Cross Sections Mackenzie River at Swimming Point, T. Blench and Associates March 1973. I'd like you to take a look at these please.

Just while Mr. Mirosh is looking at these, Mr. Spafford did you have this information as part of the data that was provided to you by Foothills?

WITNESS SPAFFORD:

A I don't believe so.

Q Have you had a chance to review those drawings, sir?

WITNESS MIROSH:

A Well it would depend on the sort of questions you are going to ask.

Q Well, let's carry on and if we find that you are going to need some more time to look at them, we will deal with that when we come to them.

MR. HOLLINGWORTH: Do you have other copies of those drawings?

MR. MARSHALL: I'm sorry, Mr. Hollingworth, we just had two copies run off. The reports I know you have. We could, if you like, get you photocopies made if you feel that you require them.

MR. HOLLINGWORTH: It depends again on the questioning, but I certainly would like to have copies of them now.

MR. MARSHALL: All right. I'm sorry about that, Mr. Hollingworth. I overlooked making additional copies of it, but it may not be necessary. We will see if we run into some difficulty in not having the drawings in front of everybody. If we do, we will perhaps take a break and get copies made.

Q Now sir, the --

THE COMMISSIONER: Well let's see how far we get anyway.

MR. MARSHALL:

Q Would you look at the drawing, it's the index mosaic.

A Yes.

Q The line marked 600, MSP 600 just upstream of Holmes Creek is, I understand it, at almost the identical location as proposed for the Foothills' crossing. Would you agree with that?

A It looks close, yes.

Q And sir, would you look at the drawing that gives the channel cross sections at that point, it's entitled "Cross Sections", and you will see that the first of the three charts shows Section MSP 600?

A Yes.

THE COMMISSIONER: Well, Mr. Marshall, you are now talking about things that don't appear in the alignment sheets, and maybe you should wait until we have photostated this. I think that the rest of us should have some idea of what you and the witness are discussing, and --

MR. MARSHALL: I'm sorry, sir.

THE COMMISSIONER: -- if you don't mind?

MR. MARSHALL: Yes, certainly we can have copies made.

THE COMMISSIONER: If you can go on with something else.

MR. MARSHALL: Fine.

Q Sir, there is quite a lengthy part of the cross-examination that I have left that pertains to these particular drawings. There are facilities for copying here in the hotel, it's just

three pages. I wonder if we might take a very brief adjournment, and I'll arrange to have copies made.

THE COMMISSIONER: All right. Make some for Mr. Scott and Dr. Fyles and Mr. Bell and so forth, and so on.

(PROCEEDINGS ADJOURNED)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. MARSHALL:

Q You've had a chance to look at these drawings, Mr. Mirosh?

A Yes, the break has given me a chance to review it.

Q Do you agree that the line that is marked as MSP 600 represents the Foothills' crossing location? It is very, very close to it?

A That line agrees with the crossing shown on 0200-03.

Q Right, and you'll see the proposed crossing for Arctic Gas is marked there with a heavy black line, that's about a thousand feet upstream or perhaps a little more?

A Yes, that's correct.

Q And just so that it's made clear for the purposes of the record, Mr. Commissioner, my instructions are that the dual crossing, the second line of dual crossing, will be about a river width downstream of that heavy dark line shown on the

drawing, the index mosaic, so it would put it some distance downstream of Holmes Creek, the mouth of Holmes Creek. Yes, I have another drawing --

THE COMMISSIONER: You mean upstream of Holmes Creek?

MR. MARSHALL: No, downstream. Upstream is near the bottom of the drawing, sir. You see the little arrow --

THE COMMISSIONER: Downstream, all right, well the Mackenzie -- that arrow is flowing downstream -- upstream, right, all right I am with you. I really am with you.

MR. MARSHALL:

Q You have in front of you the channel cross section at that point?

A Yes, I have the drawing called E6-2.

Q Right.

Would you agree that the elevation of the river bottom is about 42 feet below the water level?

A Yes, the drawing shows that, that's correct.

Q You then propose to put your pipe 25 feet deeper?

A Yes, perhaps this is the point to bring something out that I was able to review at the short break we had.

The alignment sheet 0200-03 which is the Foothills' alignment sheet, does show a

river crossing at the location which is labelled on the Arctic Gas documents as MSP 600. This is a crossing which we looked at in January. Of course, in January we had all of the Canadian Arctic Gas documents as well, and we were aware of where their crossing was, which is at what is labelled MSP 500 on the Arctic Gas documents.

At one point, we had decided that we might use MSP 600. This is shown, in fact, on our alignment sheets. We subsequently chose the location marked as MSP 500. Unfortunately, this was not corrected on this particular Foothills' application document, which is alignment sheet 0200-03. The significance of not catching that particular error on this alignment sheet is not important to us, in that our geotechnical work and our design crossing is based in fact on the Arctic Gas crossing, and this is shown in a subsequent drawing in the alignment sheet documents of Foothills. So to that extent if the point that we are getting at is that there is an error on this alignment sheet, that's correct.

Q I guess I've got the problem in that that's really all I've got to work with.

A I'm sorry.

Q I wouldn't have gone into this at all, Mr. Mirosh, if we hadn't had a talking to from yourself and Mr. Walker, about how much -- how careful you were going to be in all your river crossings, and what a conservative approach you were taking and so on, and this is really what led into the whole thing, and I guess I've been led into this by assuming that you

intend to build your crossing where the application says you intend to build your crossing, so you can understand how I have been led into this line of thinking.

A Well yes, but there is another drawing in the application which does show the crossing which you have been leading to, and that is our design drawing, so that in effect the worse that could have happened is you would have been confused about which crossing we were taking.

THE COMMISSIONER: That's the worst case.

MR. MARSHALL: There's no doubt about my confusion on this sir, that's been made quite clear I think.

MR. SCOTT: I think Mr. Marshall just fell into a trap.

MR. MARSHALL: Well sir, you had indicated that you were going to bury the Foothills crossing to a depth greather than the Arctic Gas crossing, is that still the case?

A Yes, I understand that the 25 feet which we propose at that location is greater.

Q Are you putting that 25 feet in the bottom of the scour hole that is located in this area?

A Yes. The 25 feet should be at the lowest river level elevation.

Q I take it you've selected this 25 feet because Mr. Spafford in his report talks about the -- who didn't have all of the data, apparently, he didn't have the Blench reports says "that ample allowance should be made for the crudeness of the analysis and the lack of relevant data for design?"

A Yes, I think Mr. Spafford indicated that in his direct as well, that it was very preliminary.

Q Do you know sir, what the difference is between the depth at which Foothills proposes to bury its line at this crossing, and the

depth Arctic Gas proposes to bury its line at this particular point?

A Well if I can recall correctly, I believe Arctic Gas is using 20 feet.

Q Mr. Spafford on page 8 of your report you refer to a hanging dam and I assume this is a hanging ice dam is that correct?

WITNESS SPAFFORD:

A Correct.

Q Could you please explain the conditions which are normally necessary for such a dam to develop?

A Yes, the conditions under which they develop are usually that the stream velocity above the location where the dam develops is such that an ice cover can't form across it, and therefore the water remains open, and continues to make ice in cold weather. This ice deposits upward onto the first piece of/cover ice it comes to, as it proceeds downstream, usually in some quieter stretch of the river, and as it deposits upward, it thickens that particular piece of ice cover. This eventually causes an increase in the gradient locally and raises the whole water level upstream so that eventually the ice cover can migrate upstream, this is the sort of mechanics of ice cover formation in cold weather.

Q Do these conditions obtain at the east channel?

A I don't know. I looked at this and I believe that there is a very -- what data

I could find on it indicates that probably there's a hang dam -- a very thin hanging dam develops at at that restriction.

Q Sir, have you examined Foothills third crossing in the Mackenzie?

A I'm not sure what you mean by the third crossing?

Q Well they propose to cross the Mackenzie with the supply line as I understand it going to Yellowknife. The crossing would be at Fort Providence?

A No sir.

Q Do you have any information as to whether or not the conditions required for the development of a hanging ice dam exist in that area of the river near Fort Providence?

A No, I don't.

Q Do you have a model or analytical method for predicting scour associated with an ice dam?

A No, not at present.

Q How do you propose to advise your client on potential scour associated with this ?

A Well first of all. I will try and determine whether an ice dam is a significant problem or not and that's a matter of field observation in the wintertime.

Q I see.

You might then particularly want

to take a look at this crossing near Fort Providence, we have some information that this phenomena has been observed there.

Mr. Spafford, could you turn to answer 48 concerning the effect of pipeline on sub-surface flow, that's on page 20 of your prepared evidence?

Could you tell me sir if you have some estimate or opinion as to the permeability required, to prevent frost bulb formation?

A No sir.

THE COMMISSIONER: What page is that again please?

MR. MARSHALL: This is on page 20 sir, in answer to question 48.

MR. HOLLINGWORTH: Could I hear the question again please.

MR. MARSHALL:

Q Do you have some estimate or opinion as to the permeability required to prevent frost bulb formation?

A No, I haven't.

Q Sir, in several places you refer to the maximum water levels, designed water levels, probability of peak run-off, would you please clarify or define what the designed water level criterion is on the Foothills project?

A It varies from location to location, I think, and in the preliminary estimate for the 11 stream crossings referred to, I used the one

in one thousand year return period flood.

Q The one in a thousand year flood?

A That's correct.

Q Now sir, I'd like you to turn to Dr. Neill's text, as I mentioned to Mr. Hollingworth, I wanted to ask some questions on it. This relates to the matter of scour prediction.

The text is a standard text used in river engineering and it's one that you've relied upon and Foothills has relied upon?

A I've used it.

Q Well I think it is relied upon by Foothills in its list of documents, is it not?

Dr. Clark tells me it's in the references to your report sir.

A Yes, it is.

Q Would you agree that Neill uses essentially the same approach as Blench , he has modified some aspects to make regime theory more useful to bridge engineers?

A That's what Neill's book says, I trust it's correct.

Q Yes well I'll take that then.

Would you look at pages 86 to 88?

A Yes.

Q These are the formulae used for scour prediction?

A Correct.

Q And you're familiar with equation 4.4 on page 86 pertaining to that?

A Yes.

Q Would you agree that Neill's average flood depth D sub F is essentially equivalent to Blench's regime depth D sub R?

A D sub R.

Q That's regime depth according to the Blench theory?

A Okay, without checking Blench's book, I don't remember that, I'm sorry.

Q But you accept it?

A I'll accept it.

Q I'm advised by Dr. Clark that is correct.

A Okay, well I am accepting Dr. Clark's advice then.

Q And that to estimate the maximum scour depth which may be achieved at any point in the channel bed, even in a straight uniform reach, this depth Df or Dr must be multiplied by a factor greater than 1?

A Where is that?

Q Well this is, as I

understand it, how you use this formula.

A Okay. Yes, it is multiplied by a factor greater than 1, depending on the channel alignment and whether you are placing an obstruction in the channel.

Q Well to go from the average to the maximum, you have to multiply by a factor greater than 1?

A Oh, all right sorry I don't follow you then. Can you go through that again?

Q To estimate the maximum scour depth which may be achieved at any point in the channel bed, even in a straight uniform reach, a depth of Df or Dr must be multiplied by a factor greater than 1?

A I --

Q I'm emphasizing the maximum in scour depth.

A Okay, well there is some condition applied to that. I'm not sure where to look in this book, but it is with reference to a non-uniform flow, a non-straight alignment or to obstructions in the stream.

Q Well let's take the straight alignment then.

A Yes, okay.

Q Okay, fine, we're ad idem at this point.

A And in that case, theoretically if the factor is 1.

Q I see. I refer you to your report of February of 1975. Now, look at the bottom of page 6, sir. The bottom of the page you have an equation, you say -- and I'll quote the text, "The above method of determining the depth of scour channel requires solution of the following equation", and you set out the equation. Right?

A Yes.

Q Is that the equation shown in the Neill's text?

A That's equation 4.4 of Neill's text.

Q Right. I take it there is a typographical mistake in that D sub I has been omitted?

A THat is indeed correct.

Q Subject to that typographical error, it's Neill's formula?

A That's right, you are the first one to catch that error.

Q I wasn't the first one, sir. Sir, you say at the top of page 7 in your report, you refer to D sub F as the maximum depth of scour. That really should be the average depth, shouldn't it, if you are working through the equation? I have underlined that part of it in the section of Neill's text that is before you.

Right at the top of page 7 you say "Where D sub F is the maximum depth of scour" that's in your report.

A Yes, he shows D sub F though on the figure 410, and he shows that as a straight line. I don't call it necessarily average depth of scour, because it's indicated as a line across part of the stream bed.

Q Well sir, the particular portion of the text that I was interested in is in the explanatory notes for this equation, 4.4 which we agreed we were talking about, and in the note it explains, I have underlined this, "D sub F is visualized as the average scour depth to be expected in a long straight reach of the same net width as the proposed waterway openings".

A That's correct. That's referring, I believe, to a longitudinal section in actual scour you would find that the bed will rise and fall at various locations, that's an average. That is my interpretation of that anyway.

Q Is it correct, sir, that nowhere in your calculation of maximum scour have you employed a multiplier as required by either the Neill or the Blench approach?

A No, I didn't. I added an allowance after it was all over, but in fact on the east channel I didn't rely on that method.

Q Oh you used some other method, did you?

A The one referred to in the report, where I estimate the rate of transport of material and try and make an estimate of the time

required to create a scour hole.

I might add that I find that Blench method very difficult to apply in the east channel situation.

Q I see. Well Mr. Davison, if I can get back to you for a minute, it is obvious from your resume and your comments, that you and your firm have had extensive experience in geotechnical engineering in permafrost terrain, and that it's been apparent from our discussions there are certain technical details on which you, or some members of your firm, and consultants to Canadian Arctic Gas disagree.

What I am interested in, sir, is this; whether or not on the basis of your experience and that of your firm, and really regardless of who builds the pipeline, is it, in your opinion possible to construct a safe, secure and environmentally acceptable pipeline down the Mackenzie Valley?

THE COMMISSIONER: I think we are going up, aren't we?

WITNESS DAVISON:

I think that they are, yes.

Yes, I am quite sure.

MR. MARSHALL:

Q Whether one builds going up the valley or builds going down the valley, the same answer applies?

A Right.

THE COMMISSIONER: I guess

that completes your cross-examination.

MR. MARSHALL: I have just two more questions really, sir, and Dr. Hwang, you have been working on the engineering aspects of constructing a pipeline down the Mackenzie Valley for a number of years, and you've been involved with the Advisory Board monitoring the construction of the Alyeska Pipeline.

Q Now sir, on the basis of your experience with these projects, plus your other experience with permafrost engineering projects in the Arctic, regardless really of who builds the pipeline, would you agree that it is possible to construct a safe, secure and environmentally acceptable pipeline up the Mackenzie Valley?

WITNESS HWANG:

A Yes I do.

Q And Mr. Spafford, it's obvious that we may not have complete understanding on certain of the technical aspects of your particular field of expertise, and apparently there -- some of the technical data that's been available hasn't been made available to you that pertains to the Mackenzie Valley, however you have carried out independent studies for the E.P.B. as well as for the federal government, and I want to know whether in your view, and with respect to your particular discipline, you consider it is possible to construct a safe, secure and environmentally acceptable pipeline up the Mackenzie Valley?

WITNESS SPAFFORD:

A Yes, I think it is possible.

THE COMMISSIONER: Can I ask you a question, Mr. Spafford?

THe question Mr. Marshall put to you, is it possible to construct a safe and environmentally secure pipeline up the Mackenzie Valley, gas pipeline, there may be another question that should be put, and that is do the plans of Foothills, in your opinion, at their present stage, satisfy you that the -- that if implemented, they would result in a safe and environmentally secure pipeline?

A No, I would have to express some reservations at this time because of lack of data in certain areas.

MR. MARSHALL: No further questions, sir.

THE COMMISSIONER: Thank you. Well, do you have many questions, Mr. Bell?

MR. BELL: I just have one question sir.

THE COMMISSIONER: Well ask it now then.

CROSS-EXAMINATION BY MR. BELL:

Q Mr. Claridge, I see from the resume of your qualifications and experience that you've been involved in the hydroelectric development at Snare River and I take it that Klohn Leonoff provides geotechnical advice on that project, is that correct?

WITNESS CLARIDGE:

A I think Mr. Davison could answer that better than I. He managed that particular project.

Q Is that correct, Mr. Davison?

WITNESS DAVISON:

A Yes, that's correct.

Q It's my information that that project ran into some major geotechnical problems after construction had commenced. Is that your understanding?

A I wouldn't consider them major problems. The designs that we came up with were economically to them, unacceptable, and so that we have

revised the locations, locations were revised on a geotechnical basis.

Q The dam had to be moved several miles, I understand, is that correct?

A There were other considerations that were non-geotechnical as I understand that the dam was also moved for.

Q So you're saying that the dam was not moved for geotechnical reasons?

A Not entirely no.

Q But partly?

A That's right.

Q And I take it that Klohn Leonoff was providing geotechnical advice on this project prior to the discovery of these problems?

A That's correct.

MR. BELL: Thank you, that's all I have.

THE COMMISSIONER: What were the geotechnical problems that, at least in part, meant that the dam could not be built at the place where Klohn Leonoff had originally said it should be?

A We had large, very high dikes on permafrost, very great depths of permafrost. and it was necessary in order to create safe structures, to remove the material in the foundation area, to remove the problems of great settlements on this dyke.

Q To remove the problem of what settlements?

A The settlement upon degra-

dation of ther permafrost underneath the dikes. and the cost of removal was too great.

Q At the site originally chosen, these costs would have been too great, that was NCPC decided, was it?

A That's my understanding. It would have been technically feasible to build at that site, but costs ruled out that.

Q Did NCPC so far as you know, take the position that it would not have been technically feasible. I know that you say it would have been technically feasible, did they take the position that it was not technically feasible and that was the governing consideration, not the matter of costs?

A They accepted our recommendations regarding what they would have to do and I would understand from that that they accepted that it was technically feasible.

THE COMMISSIONER: Okay, thank you. Well we'll stop for coffee.

(PROCEEDINGS ADJOURNED)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

CROSS-EXAMINATION BY MR. SCOTT:

Q I would just like, if I could, to begin by seeing that I'm certain I understand the responsibilities in this project that each of you bear.

First of all, Messrs. Claridge and Davison, I gather that the functions that you are presently performing are those that are set out in paragraph number 16 of Mr. Davison's answer on page number 7?

WITNESS DAVISON:

A That is correct.

Q And those responsibilities run all the way from drainage and erosion assessment to qualitative assessment of thermal disturbance and frost action?

A That is correct.

Q And just while we are at it, Mr. Davison, would I understand that Mr. Claridge has the front line responsibility in those matters, and your function is as a senior administrator in, if I can put it this way, in a non-clerical sense and reviewer of work and assigner of projects?

A A reviewer, essentially, yes.

Q Yes. Dr. Yip, is there

anybody in-house at Foothills who is providing parallel or comparable services to the work that Mr. Claridge and Davison are doing?

WITNESS YIP:

A I don't know.

Q Well now, Dr. Hwang, do I understand that you, with the assistance of Dr. Yip, are retained as I think your evidence said, to do -- to be responsible for the quantitative assessments of thermal disturbance and frost action?

WITNESS HWANG:

A Yes.

Q Now, Mr. Spafford, as you have said I think in paragraph 35 on page 17, your responsibilities to date have been restricted to assessment of hydrological problems in certain cases referred to you?

WITNESS SPAFFORD:

A That's right. I have been engaged on specific problems. I have been engaged to -- on specific problems.

Q Yes. Not generally but with relation to specific issues or fact situations that have been put before you?

A Correct.

Q Well now, Dr. Yip, is there anybody in-house at Foothills who is performing the same kind or parallel functions to Mr. Spafford?

WITNESS YIP:

A No.

Q Well now, is it correct, Mr. Mirosh, that Mr. Spafford will have no responsibility for river crossing design, and that that is the responsibility of Mr. Walker who appeared on a previous panel?

WITNESS MIROSH:

A Well Mr. Spafford does have an element of responsibility in providing some parameters --

Q All right.

A -- to Foothills.

Q He provides hydrological information and Mr. Walker does the designs, based on the information provided?

A Yes, by Foothills.

Q And do I understand that Mr. Claridge and Mr. Davison's firm will be responsible for design for slope, drainage and erosion?

A Yes, this is the area they have been working in.

Q And I take it that that is at the moment, at least, the complete geotechnical team?

A Well, the people you see before you are representatives of the team. There are of course many others that support these people.

Q But these are the leaders of each of the disciplines that are retained by Foothills to present a geotechnical assessment of the project?

A Yes.

Q Well now, let me see if I

can follow up something that I interjected yesterday when Mr. Marshall was questioning, and I really direct this question to the three geotechnical heads of consulting firms, and by that I mean Mr. Davison, Dr. Hwang and Mr. Spafford.

I take it that in each case when you were retained, either six months or a year ago as the case may be, you were provided by Foothills with certain information which appeared to derive from the study that Arctic Gas had done in preparation for its project. Would that be correct in every case?

WITNESS MIROSH:

A Did you want me to --

Q No, I would like each of them in turn to.

WITNESS HWANG:

A In my case, yes.

Q Mr. Spafford?

WITNESS SPAFFORD:

A I'm not entirely sure of the origin of all the material I was given.

Q You were provided, however, with certain material?

A Right.

Q Yes, and Mr. Davison?

WITNESS DAVISON:

A We were provided with certain material backed up by our own previous file.

Q All right. Well now, would it be correct to assume that your first job, each

of you, confronted with that material at the moment of your retainer, would be to make a general assessment of it?

A Yes sir, that was what I said in the direct.

Q Dr. Hwang?

WITNESS HWANG:

A Yes.

Q And Mr. Spafford?

WITNESS SPAFFORD:

A Yes.

Q And I take it that each of you, following that assessment then began to develop approaches or programs designed either to modify or carry forward the work that at that point appeared to have been done. Would that be correct?

WITNESS DAVISON:

A Yes, sir.

WITNESS HWANG:

A Yes, in my case.

WITNESS SPAFFORD:

A The material I was provided with was basic data such as river soundings, contours, drill hole information, so I --

Q But even in your case, Mr. Spafford, with perhaps less information, as we have seen, I take it that your function having assessed it, was to develop a program or an approach to identify and then resolve whatever geotechnical problems were put before you?

A That's correct.

Q And would it be correct in each case to say that at this stage, running from six months to a year after your retainer, you are in the course of developing programs, and that you have begun work on some of them, but essentially none of that work is approaching completion? I don't say that critically, obviously there are time frames here that may require that, but would that be a fair statement, Mr. Davison?

WITNESS DAVISON:

A I wouldn't say that we are developing programs, we are developing methodology that we are going to be using during final design. Program to me is connotating that we are studying specific problem area. We are really developing our methodology that is going to be used in the final design approach.

Q Let me put the question this way. All of us know that final design is a function that will not be in any sense fully performed until well after the regulatory approvals have been granted. That is generally understood by the panel, is it not? I assume that it is --

WITNESS MIROSH:
A Yes.

Q Well now, I am not talking about final design, I am talking about a comprehensive or overall geotechnical statement of the project, and I take it that whatever stage we are at, Mr. Davison, you would not assert at the Inquiry at this moment, that Klohn Leonoff is in a position to give a

comprehensive or overall statement in geotechnical terms of the project?

WITNESS DAVISON:

A No sir, that we have in our direct evidence indicated the areas we are centering on in which we feel that we are having to gather additional data in order to arrive at for final design.

Q In that sense, you have before you the objective which is an overall geotechnical statement and you're developing some techniques to enable you to move towards it.

A That is correct.

Q But you're not much beyond that stage now and I say this without criticism.

A We haven't presented our final report that shows that this is the method that we will be using in final design of this.

Q And Mr. Spafford, I take it that in your case, that would, even though you have been only assigned to a number of specific problems, that that would be a fair statement, would it not?

WITNESS SPAFFORD:

A I think perhaps I better outline my involvement because I'm not sure of that. The initial assignment was related to three specific jobs which were completed by about March 75 and reported on. Subsequently, around the first of August, we were brought in again with several more specific requests which are still in progress.

Q So your position, if I understand it then, is a little different. You have been asked some specific questions, and have not been given any general responsibility for hydrological assessment?

A I believe that's correct.

Q Yes, and in some cases you've answered those specific questions, as your reports referred to indicate and in some cases you're working on the answers preparatory to making reports?

A That's correct, yes.

Q Now, Dr. Hwang would you agree, as perhaps Mr. Davison has, that you're at much the same stage. You are in the course of developing approaches so that you can move to a comprehensive overall statement of the geotechnical aspects in your area?

WITNESS HWANG:

A In my area I would say the approach, from a significant part of it, is there, but I sure like to have more detailed data, to go beyond that.

Q So that it would be fair to say that you're not in a position to at this time, at this point in time, to make a geotechnical statement about the project that satisfies you, as being comprehensive?

A Quite true.

Q Well now I take it then that if all would agree that -- and let's be candid about it, that you in terms of a comprehensive assessment are, as the fates would have it, are well behind the stage at which Arctic Gas presently finds itself. in each of your disciplines?

WITNESS MIROSH:

A May I give one encompassing answer?

Q Well I'd like the answers of the people who are the experts in the field, but Mr. Mirosh, by all means go ahead. Whose ever got

the bucket can bail.

I didn't mean that cynically sir.

A Well I think that at one point in time, going back to September of last year, we had access to all of the Arctic Gas information at that time, but that they were -- that they made available to us, and at that point in time. we were at the same stage. I would say as they are, because we had that information, and that was information that was paid for in part by Trunk Line and there were many people from that organization that followed it. So that to say we're starting from zero then was not fair and I think you may have said that yesterday.

Since that time, we've studied that information, and built up on it. For example on the routing, we have probably gone further than Arctic Gas at this point. They've been preoccupied with major changes, we have since beginning on routing, been refining the route. We have now a number of places we know that we're going to consider as refinements to the mainline. In that sense, I would suspect that we're at least as far, is not further ahead, in the areas in the disciplines that are at this table,. They have all of the information to a point in time that Arctic Gas had. They've built upon this,perhaps they've diverged somewhat from the point that Arctic Gas was at, but the paths are probably more or less parallel.

Q Well let me ask the question then of the experts in this fashion. I take it that each

of you, Mr. Davison or Mr. Claridge Dr. Hwang or Mr. Spafford, are familiar with the geotechnical evidence that has been put forward by Arctic Gas at this inquiry and perhaps some of you will have read or looked through the examinations and cross-examinations, is that true in every case?

WITNESS HWANG·

A Yes.

WITNESS SPAFFORD·

A I've read some of it.

Q Pretty boring, isn't it?

A Yes sir.

Q Well now I take it would each of you, bearing in mind the necessity for work up time that obviously confronts you, would each of you agree that in terms of your own disciplines, you are not at a stage where you can make, at this moment in time, the kind of overall geotechnical assessments that Arctic Gas has been able to present and there's no criticism in that remark. Mr Davison or Mr. Claridge?

WITNESS DAVISON·

A I would like to make one remarks, that at times it may appear that geotechnically, because we have taken a new route, that we're behind Arctic Gas. However, I would like to add that we are in some respect taking a fresh approach. We're aware of what Arctic Gas has done and/in areas where we don't agree with what they've done we haven't closed our minds to taking a new approach. We think it's a better one sometimes, this is a matter of opinion and I submit that

although we may be different and we admit that we have further work to do, that we are nevertheless in some areas ahead and certainly not behind.

THE COMMISSIONER: At any rate, are you telling us that you try harder.

A I think when one has been working on a job for five years perhaps, one becomes a little blind to new ideas that perhaps we supplied.

MR. SCOTT:

Q I'm prepared to give Foothills the award for the fastest pumps in town, there's no doubt about that, but what I'm really asking is even though you diverge and take different views, and I'll be coming to those in a moment, would you agree that as a matter of timing and work, you're not yet at the stage, where, even if your view differs, you can put forward an overall geotechnical view in the way that the geotechnical people that we've heard from from Arctic Gas are able to?

A We may not be as firm and conclusive in our opinions, but we feel that we can do as well.

Q All right. Dr Hwang?

WITNESS HWANG:

A In our own way, I would say I was involved with Gas Arctic till '74 and after that I also applied my experience on other fields so in my own way, I would say I may be ahead.

Q All right. Mr. Spafford, I

take it that as you've been answering specific questions, rather than preparing a geotechnical approach, perhaps the question doesn't apply to you. Would that be fair?

WITNESS SPAFFORD:

A I have looked at at least some of the documents supporting Arctic Gas's submission. the reports on my specific area. I really can't see that their efforts or even their conclusions perhaps vary a great deal from mine and the ones I put down.

Q I will be coming to that but I take it that again, your emphasis has been to respond to specific questions, at specific riversites, rather than provide a general geotechnical assessment?

A Yes.

THE COMMISSIONER: Could I ask something, Mr. Scott. You have these two pipeline companies. that want to build this pipeline. Neither company is prepared to go to final design until it receives the right-of-way from the Minister of Indian Affairs and Northern Development and his colleagues the Cabinet and until it receives a certificate of public convenience and necessity from the Cabinet, on the recommendation of the National Energy Board. So that, if this pipeline is built, it will be built, as things stand at the present, by one of these pipeline companies. Now, if that occurs, that is if you, Foot-hills get a certificate of public convenience and necessity, and you've got a right-of-way then you will be in a position to go to final design, but there will be out there, a great many people connected with Arctic

Gas as employees or consultants who will have a great deal of knowledge about this whole project, one hesitates to say they will be out of a job because they are the kind of people who are very in demand, especially the lawyers.

Let me give you an example.

One of the witnesses for Arctic Gas was Dr. Morgenstern, who I gather is a very distinguished member of the engineering profession. If you got the right to build the pipeline, then you go to final design, would it be your object,notwithstanding the distinction that you and your colleagues have all earned in your respective disciplines, would it be your intention to retain people like Dr. Morgenstern to assist you in going to final design? Is that what we may be looking at at the end of the road?

WITNESS MIROSH:

A I think that if we were awarded the right to proceed by having regulatory approvals, we would need a great deal of engineering assistance, in addition to those people that we have engaged. Certainly, it would be a matter of contractual arrangements to hire consulting firms in addition to those which we have, who are experienced in the area. The obvious ones would be those that are working on the project on the other side.

But to get back to one other point in major engineering projects, there are distinct phases that one goes through and it's a rule for every project. One goes through a conceptual phase, or feasibility phase in order to prove that it's worthwhile proceeding further. One then goes into a preliminary design phase, where one does the sort of work that we are doing, and doesn't invest a great deal of money in engineering as one would do in final design, and then once approval is either granted or very close to being granted, then one enters the final design phase. This

is quite a normal course of events.

THE COMMISSIONER: Oh yes, we understand that. No one is quarrelling with that. We have been told by Arctic Gas that they don't want to go to final design until they have been assured that they are going to be building this thing.

I take it the answer to that question was yes?

A Yes, we would use all the expertise that we could find for this project.

THE COMMISSIONER: And they would be sitting right there on the other side of the room?

A Yes, of course we would like to get people that are in the area to us, and in Canada that are experienced.

MR. SCOTT: Well if you get the permit, may I put in a word for Les Williams? He seems like a good fellow.

Q Now what I would like to do, I refer you to the fact that the Minister, in referring this application to the Inquiry, has asked the Inquiry to concentrate on the differences and in certain aspects that means the differences in routes and so on, and we are beginning to learn something about those. But what I would like to do is ask each of Mr. Davison or Mr. Claridge, Dr. Hwang and Mr. Spafford, recognizing his limited responsibility to date, or the limitations of his responsibility to date, three questions and I hope that the answers can be

presented without justification, and perhaps I should just read the questions first so you will have a chance to think about them.

First of all, have you any reservations about the approach or methodology in your discipline that Arctic Gas appears to have adopted, and then I would ask you to list your differences, without justifying or rationalizing them at the moment. We may have to come to that, but simply listing them.

The second question, have you any reservations at the present time about the conclusions or solutions that Arctic Gas appears to have proposed to the geotechnical problems within your competence?

And the third question is, does the approach of Foothills within your sphere of competence, appear to differ significantly from the approach of Arctic Gas?

Now the third question you will see is not related to your recommendations or your own personal views, but is a request for a list of differences of approach that appear.

Now perhaps I could begin by asking Mr. Davison or Mr. Claridge, whether they have, based on their understanding of the Arctic Gas geotechnical approach, whether they in their field of competence, have any reservations about the approach or methodology that Arctic Gas has adopted.

WITNESS CLARIDGE:

A Yes we have.

Q Could you list them in point form?

A I don't know if it's a listing, it's a general comment. It's one that we have been attacked on the last two days, and that is in the preparation of reports, what have you done, what studies have you and so on and so forth, and that is the type of reports that have been issued by Arctic Gas very frequently, although they are theoretically very good, have very good back-up, have I would say a very excellent scientific background, that their application is not demonstrated to this pipeline and to the approach to problems that have been raised.

I would say my concern is that perhaps they are bogged down in a heck of a lot of paper, that the studies seem to be very office oriented, and our difference in this regard, and perhaps one reason why we don't have very many reports, is that we have been concentrating on getting out and seeing the conditions as they are, making sure we understand the problems before we sit down and do a study that may, in fact be in error, because of lack of observational data.

Q Well, would it be correct to say that that difference could be characterized in the most simplistic terms as the difference between, as you conceive it, a theoretical orientation as opposed to an observational or data approach?

A Yes, that's true at this stage. I feel the theoretical analyses are also important but they should not be emphasized to that extent

at this stage. I might make the points that onstability I have mentioned that we have, I feel, obtained sufficient slope data that permits us to justify the selection of a route with more confidence than what I understand has been available to Arctic Gas, at least at the time that we were given material. The same would apply to drainage and erosion.

Q I'm concerned at the moment simply to get a list of your reservations about their approach or methodology within your discipline. Now, you have listed an all-encompassing one. Are there other reservations you have in point form about their methodology or approach?

A That remark that I made in general principle applies to areas of slope stability, as well as drainage erosion, and as well as structural design, because they are all related to location and development of a methodology. This is what we feel is important, and that other more detailed, more refined studies, must await a site specific stage in the project, that I think both sides agree has not been reached.

Q All right. Well now, is that in sum, the reservation of Klohn Leonoff with respect to approach methodology?

A Yes sir.

Q Well now the next question. As you understand their conclusions or solutions proposed, have you any reservations about Arctic Gas' conclusions or solutions in your territory of competence?

And what are they? First of all in point form, if we can do it.

A Conclusion is a word I wouldn't agree with. I think it's too broad.

Q Well how about solution?

A The application of suggested solutions I've indicated is questionable, because of the lack of data.

Q Well let me be more specific. You no doubt have seen in the evidence of Arctic Gas and indeed in their application, solutions that they propose for various -- in general terms, quite often, for various geotechnical problems relating to slopes, drainage erosion and so on. You have told us about your reservation about methodology. Are you in a position at the present time to express any reservations about those solutions which they have proposed?

A I think that Arctic Gas is about as vague as we are in how solutions would be applied where, so I would say I do not disagree with their solutions and they have not been specific as to how they would be applied.

Q Mr. Davison, anything to add to that?

WITNESS DAVISON:

A No, I agree with the idea that as I mentioned in my direct testimony about erosion and drainage being on alignment sheets. WHat I was saying is I failed to see how that specifically would

be carried into a construction phase, particularly with respect to the spacing, the proper spacing of the drainage breaks.

Q Well now --

THE COMMISSIONER: Excuse me, I didn't quite follow that. You must have mentioned it -- would you repeat that, please?

A As I indicated in the direct testimony that in the alignment sheets there is drainage and erosion control design on the Arctic Gas submission, and I failed to see how that design could be properly implemented during construction. It indicates a rating of spacing of breaks, but if that was submitted to the field, the breaks as we now see, could be located at the wrong place. They would not be, unless they have done their field reconnaissance on the ground, those breaks may be in the wrong location, but they did not indicate that they were going to take that step to ensure that the breaks are at the drainage paths.

THE COMMISSIONER: Do you agree with Mr. Claridge's general criticism of Arctic Gas' approach, that is that it is theoretical, whereas yours, he says, is on the ground, practical?

A It appears to us, because most or many of the reports that we see have been prepared are theoretical, essentially conceptual reports as against site specific data or the indication that they are going to be gathering this site specific data to prove that they are -- the theory is applicable to

that route.

MR. SCOTT:

Q Well now Mr. Davison, or Mr. Claridge, the third question and you may already have answered it but I propose to put it anyway, apart from what you have told us in response to my questions, does the approach of Foothills in your area of discipline, appear to differ significantly from the approach of Arctic Gas?

WITNESS CLARIDGE:

A It all depends on what significance you attach the word significantly. I don't think we're terribly far apart. I think the word that I would like to use is one of emphasis that as professionals, we're all subject to a great deal of advice, both through papers and from people who have actually built pipelines or are working on them and when subjected to a great deal of information, one must place priority and emphasis and we have chosen, I think, a different emphasis, I think we're aware of the same things but we have put different weight on different things and we feel its in an order such that we can be more confident for this stage of the work as to where we are in the field, why we're there and I think this has implications for others, that we don't want to be going back in collecting site specific data in a year or two that's going to change the line radically. I think we're doing that at this point so that other disciplines may get on with their work and the inquiry may finish its work and this is a point that we have worked on, we're trying to get the route set and I think we're very close to that, and you may criticize us for making those changes, at this date, but I feel that Arctic Gas will have to do the same thing later and in that respect I think we're putting the right emphasis and getting things in the order they should be.

Q Some of the people sitting behind me here are here to induce you to make changes. Don't feel that we're critical of that. You caviled quite properly about the use of the word significant, and the difficulty that created in responding to my

question. Let me put it this way. Are these differences in your judgment, matters of consequence?

A Yes, I think they are.

Q Now Dr. Hwang in your area of discipline, which is the quantitative assessment of thermal disturbance, have you any reservations about the approach or methodology that Arctic Gas has applied?

WITNESS HWANG·

A No. I will, in methodology, I will agree, in thermal analysis, Could you rephrase your question. You are asking us three questions.

The first one is the reservation about ~~their~~ approach, the second one is proposed new approach.

Q The second one is whether you have -- well let's take it step by step. I take it that we have your answer to the first question, that as you have understand it you have no difference or no reservation about the approach or methodology that Arctic Gas has adopted in your sphere?

A The first question, I already answer you.

Q All right.

A Talking about the second and third, I wonder, should the third become second and the second become third. In other words, what I'm saying is do you have reservations first and then the second, one, do you feel it is significant, what it is until one propose something to result from that.

Q Let's come to the second

one and see if we can get together on it.

A About your thermal one I would have, I don't have reservation about approach and the methodology.

Q All right. Do you have any reservations about the conclusions or solutions that appear to have been derived by Arctic Gas in your own sphere?

A On the thermal analysis part, I agree. In other words, it will not have a significant difference, so I answer three questions at once.

Q All right. But the answer to your third question would be that the approach of Foothills within your sphere of discipline does not appear to differ in any significant degree from that of Arctic Gas?

A In the geothermal part, methodology no. But we do feel we will have more input data, one was saying about the input data, we may have a better understanding of the problem. Now I am actually covering two parts, one is the geothermal analysis and the other one is frost heave. Now, about frost heaving, first of all, about the reservation about methodology. I don't have, because that kind of principle used in the frost heaving, had been accepted, had been published in the literature actually the concept was done since 1974, if I recall that correctly

Now the second one is do I have a real good feeling about the overall result

Q I'm sorry. I didn't get

your observation?

A Do I -- the second question is the proposed one. What I would like to do I would like to have a model on it so that I can interpret the results from the accepted theories and therefore I am much more confident in relating their existing test data which is in the order of about 200 days to 300 days and project that back to about 20 years of the pipeline. So that proposed -- the second question on the proposed approach I would say I would like to do more about it.

Q Can I stop you there just for a moment. Do I take it that when you make that observation in response to the second question, that you would like to do more, what you are saying is that you would like to have more or better input parameters to the model?

A Better not only in the input parameter, but also about overall mechanism.

Q About --

A The overall mechanism of the frost heaving. Now, come to the third one, is not going to be different significantly after a study, then I would say, until I finished that one it's hard to tell, but it may not be significantly different.

Q With respect to the third question, I'm not asking you of course whether your results which will be shown in the future will differ significantly, that I would agree would be not possible to answer, at this stage, but what I am asking

is is there a significant or consequential difference in approach that Foothills is taking within your sphere of influence than that Arctic Gas is taking.

A I would say probably not because of using the same principle.

Q Well now Mr. Spafford, it may be hard for you to answer these questions in view of the limitations on your work and perhaps we can restrict them simply to the matters which have been referred to you and not deal with any general geotechnical approach to hydrology. but in the matters that have been referred to you, have you any reservations about the approach or methodology that Arctic Gas appear to have revealed in their work?

WITNESS SPAFFORD: I'm not familiar with Arctic Gas's methods on the work that I have done. I'm afraid my review of supporting data was in search of basic field information.

Q Have you read their evidence sufficiently, the evidence of Mr. -- Dr. Hollingshed and his associates?

A No. I'm not familiar enough with that to comment.

Q Well then in the areas that have been referred to you, have you any reservations about their conclusions or solutions?

A In the instance of stream crossings on the east channel, I think that their solution as presented is probably within any margin of doubt that I have in my own at the present time

so it would be a matter of their judgment against mine, I think that I would say the solution is similar as a preliminary appraisal.

Q Any other --

A In the case of hydrology, much of the background material that we did ourselves was available to them through the EPB and this is the only one I know about so it of course is similar.

Q Well let me come to a number of specific items that appear to me and about which I would like some comment. The design panel and perhaps some of you gentlemen were here to hear their evidence, made clear one difference between Foothills and Arctic Gas and that is the difference that at present appears between them on the southern limit of chilling of the gas pipeline. I think if I have it correctly, Mr. Mirosh, on that panel, explained that the basis of Foothills plan to operate the pipe above freezing south of Fort Simpson, and below freezing north of Fort Simpson was justified in terms of the general distribution of permafrost and non permafrost terrains above and below that line. I think Mr. Mirosh has said yesterday that that line has not been fixed with any precision. I'd like to ask Dr. Yip or Dr. Hwang, can you tell us in more precise terms, the basis for the choice, recognizing the choice with precision may not have been made can you tell us the basis for the choice of the southern limit of chilling with relation to quantitative studies of the geothermal conditions? How are you going to choose, on the basis of your studies, the southern limit of chilling?

WITNESS YIP:

A I would like to ask Dr. Hwang to first comment on this question.

WITNESS HWANG:

A It will depend upon the permafrost distribution and if I am going to design it, it will depend upon frost heave against thaw settlement.

Q Well I understand that is what Mr. Mirosh was telling us earlier, that it's going to depend on distribution, but what kind of distribution is going to be the determining factor? Can this be expressed roughly in terms of percentages, or --

A Percentage of permafrost?

Q Or non-permafrost?

A I would say it would be more than that. Sometimes for permafrost area you may not have a settlement problem, and sometime for a non-permafrost area, you may not have a frost heave problem, but I do accept that at the moment I am not so familiar with the soil data, so I can only give you my methodology. I have not that number yet.

Q I think that's what I want, your methodology. We know that Foothills at the moment says that they are going to stop chilling before they get to the border, and that's something that distinguishes them from Arctic Gas who says they are not.

Now, I am not asking you today where precisely you are going to stop chilling, at which compressor station, but I am asking you to list the criteria and how you will weigh them, one against

the other, when you come to make that decision?

A I only answer the question from a geotechnical viewpoint. I would weigh those two factors, but I think when I present it to management, they end up maybe with economics becomes overall factor.

Q Well we know the management in these things can overrule on almost anything, but leave that aside. You are a quantitative engineer in geothermal work, and presumably one of the factors is going to be the quantity of permafrost, as opposed to non-permafrost?

A That's right.

Q What is the measure of that quantity going to be?

A I still can't get the question.

Q Well if -- .

A The quantity in the distribution or what?

Q If one looks at a map of the line from Good Hope to the Alberta border, it becomes apparent that you are in an area of discontinuous permafrost, where there are permafrost patches and non-permafrost patches?

A THat's correct.

Q And Mr. Mirosh has said that it has occurred to Foothills that there may be a point where less damage is done by cutting off the chilling, than by continuing to chill?

A That's right.

Q And he thinks that roughly that may be at about Fort Simpson, very roughly, I don't hold him to it. Now in terms of your quantitative assessment, what are the criteria that you are going to apply to decide where you will recommend the chilling should stop?

A Well like I say, I have to have access of the route conditions from where, like Mr. Mirosh, from Fort Simpson area down, and until I do that, I really cannot give you a number in a final decision.

Q Well let me ask you in simple terms. If it should appear that at Fort Simpson, the route crosses an area that is over, let us say, a number of miles that is half permafrost and half non-permafrost, is that going to be sufficient to indicate to you that the level of chilling should stop there?

A No.

Q All right, what will be satisfactory to you?

A Because I will have to assess between these two areas, what will be the soil sediment against the frost heave.

Q All right, well then would it be true that you would want to know two things first of all, you would want to know the amount of permafrost as opposed to non-permafrost terrain?

A That's right.

Q All right, and the second thing you would want to know is the extent to which the

non-permafrost terrain will produce settlement of unacceptable proportions?

A Permafrost areas produce settlement.

Q I'm sorry, yes.

A Okay. But we have to know that permafrost area doesn't mean it always have settlement.

Q I understand that, so the second factor you will want to know, is the extent to which the permafrost area is going to produce settlement?

A That's right.

Q All right now, are there any other factors that --

A Oh yes, I had to go into the slope stability and other factors too. You are just asking on my part?

Q I'm just asking on your part.

A That's right, I present this to them and we have to discuss with all the consultants about other aspects too.

Q But in terms of quantitative geothermal analyses, those I take it, are the two factors that you will look to?

A In my part.

Q In your part?

A That's right.

Q And do I understand that

you are not able to say at the moment the weight to which you will -- which you will give to either one of those factors?

A If the weight is to depend upon the terrain conditions, then I am not able to do that at the moment.

Q All right. Well now, Mr. Claridge, Dr. Hwang has said that he is not going to make this decision on the basis of his quantitative assessment alone, that he's going to consult you or your firm and your responsibility as I see from your list, is a qualitative assessment of the thermal regime, and I wonder what the criteria that you would apply in making a recommendation with respect to the southern limit of chilling would be?

WITNESS CLARIDGE:

A I think at this point, sir, that you would be examining the site specific conditions along the route, you would have to examine the, as you point out, the percentage of permafrost, but more than that, you must have the precise soil conditions at a variety of locations, and for example, at one site you may prefer to chill and at another site you may prefer to thaw, and this is going to be a mile by mile evaluation, which afterwards must be taken in total as a decision following that type of detailed information gathering. I think Dr. Hwang has said that what he is looking at is a prediction of the effects, and I think it would be at a site specific -- on a site specific basis, and then we must all get

together and sum up and say what's best overall.

Q Well you've told us, I have no doubt that it is the only way to do it, that you would look at the site specifically to determine the soil that is there. What I want to know is what kind of soils are going to put you on one side of the recommendation, and what kind of soils are going to put you on the other side?

A Well there is no simple answer, sir, as there are construction variables that one can apply that just because one's in a, let's say not the best terrain, doesn't mean that well I should do either thawing or freezing. There are expedients such as deeper burial, route relocation is our foremost technique. If we can avoid a problem area, we do so. We try to get around the problems that we foresee through a variety of construction and location expedients, and our analysis backs up our final design which must follow.

Q Well forgive me for persisting with it, but presumably at some time, and you are not going to be asked in isolation, the company is going to say, "Mr. Claridge where, if at all, should we stop the southern limit of chilling", and presumably you are going to tell them, "Well these are the factors and these are the way I weight them, and I recommend you should stop here".

Now, I am not asking for an analysis that has not yet been made perhaps, I'm simply asking if you will list the factors, tell us how you

weigh them, one against the other, and we will await your conclusion later. What are the factors that --

A I think all I can say is the geotechnical data as they are collected would be -- well, of course, the parameters, if that is what you are getting at, would be soil type, presence and distribution of ice, ground temperature, if it is frozen ground, if it's not. Soil type again, water table level, these various items.

There would be a geotechnical assessment and then recommendations presented to the design team, and it would be carried on by them following the geotechnical recommendations.

Q Well let me -- I don't seem to be getting anywhere on that line, and perhaps it's the difference of my comprehension, but let me ask this: Have either Klohn Leonoff or Dr. Hwang been asked yet where the southern limit of chilling should stop?

WITNESS DAVISON:

A If we were asked at an early stage whether we believed that it should be at a particular location, and this was our best judgment at that time, as to stopping the chilling at the Mackenzie River.

I might mention really a point that might not be clear. We would not make the final decision as to chilling or not. We will provide the pipe designers, the environmentalist people with the figures, if you want to call it, as to how much

settlement we would anticipate, how much heave we would anticipate, and they will be incorporating it. It has to be the other area.

Q Well you were asked and you gave that opinion, on what basis did you give that opinion that Fort Simpson was the place to stop?

A This was on the basis of quite limited data at that time, a 1969 program in which we had some drill holes plus an assessment of the area -- the soil conditions that we expected subsequent to that, and we recommended to Foothills that a drilling program be carried out within this area, in order to check whether this/really gained data in this area.

Q Well was your assessment quantitative, that there appeared to be less permafrost terrain south of Fort Simpson and more non-permafrost?

A It was a judgment on the basis of the conditions that we felt would exist in that area.

Q What conditions?

A The less ice conditions, yes.

Q So would it be correct to say that you did what you could along this route to measure the percentage of ice as opposed to non ice conditions in a rough way?

A In a very rough way, yes.

Q And then you concluded that there was more non ice condition, by some percentage and therefore fixed Fort Simpson?

A This area we have looked at and are verifying or have verified it with drilling and gathered this data.

Q Have you any confidence in that judgment at the present time?

A Sir, we have gathered data as I mentioned, over that segment south of Mackenzie and percentages are being thrown around which I dislike really from the point of view that from previous experience, that they can be misleading and I might mention at this stage, within that segment that we drilled, there was a 37 mile section of that line in which there was some 75 percent of the ground, if you want me to throw out a figure, was frozen. There was another 50 mile section of that line, that had only 20 percent frozen ground, so if you average on that you might come up and throw a figure around of 30 or 40 percent, but we know from the variability. And for that reason, we feel

we have to gain the final data right along the line to reach that point of making a final judgment or final recommendation.

Q I'm just trying to clarify the process. Now if you commenced and completed a drilling program, and obtained soil data from, let us say, Willow Lake River down to the border, and in the course of that program you found that a certain percentage of ground ice was reported, and that would be one of the things the program would tell you, wouldn't it? How would you then make the trade offs that are necessary to decide where chilling should stop?

WITNESS CLARIDGE:

A I think as Mr. Davison expressed, that the various factors affecting which way you go have not been summarized. I think Dr. Hwang made it clear that he is still working on his model. He has things to do and we would certainly want to have all of the geothermal backup ready, as frostheave is critical, and prediction of settlement is critical. We're in the process of gathering the data but that by no means would be the basis alone of making a decision.

Q Well would it be correct to summarize then by saying that it is premature at this stage for you people to establish either the criteria or the data that will be required to found your recommendation, your firm recommendation as to the southern limit of chilling?

A A firm recommendation is

not possible at this time, that's correct We're in the process of getting to that but it's not possible at this time.

Q I take it that the recommendations that you have made so far, for Klohn Leonoff appears to be a determination that there is more non permafrost than permafrost and therefore, chilling might stop at Fort Simpson?

A That's correct.

Q Well now perhaps Mr. Davison or Mr. Claridge can answer this. In terminating pipeline chilling as you may do at Fort Simpson, I take it that one of the consequences of that and perhaps the prime consequence is that you avoid the potential for frost heave south of Fort Simpson?

A You will not get frost heave with an above freezing line.

Q And that you will therefore avoid a risk to which, as presently constituted the Arctic Gas application in that area is subjected?

A I think you would have to inquire from Arctic Gas whether they consider that as a risk and I don't think we've made up our minds on that yet.

Q I take it that you consider it a potential risk?

A Taking the question out of context, there are circumstances where it would be a risk. However, we feel that there are design tools to get around it.

Q I put it to you that if the problem of frost heave is not a risk, well then that's the end of the question because you simply chill the border?

A It is a risk in the absence of let's say good design and we're looking at design methods to eliminate possible problems associated with this phenomena.

Q But Arctic Gas and I hope I dont do injustice to their evidence, they say we have conquered that risk. The risk of frost heave. They may be right or they may be wrong about that but that's what they say and therefore they say, we're going to chill right to the border. The risk is resolved by us. Now I take it that because you are looking at an area to stop chilling north of the border, you are conscious that frost heave problems create a risk that may or may not be resolved?

A We are not as confident in our assessment.

WITNESS MIROSH:

A I wonder if I could add one point. There are ways of overcoming frost heave but they give you a cost penalty. so this is one thing that has to be looked at in addition to the cost penalty of running a warmer line due to the volume throughput restrictions and in addition to the perma-frost versus non permafrost.

THE COMMISSIONER:

Q You, Mr. Mirosh, are not

chilling the gas in your extensive feeder line system from the mainline to Rae, Yellowknife, Providence, HayRiver and Pine Point.

A No, that's correct, we preliminarily from looking at it, do not feel that this will be a problem since the gas temperature should be at ground temperature on that line,

Q Well if you were to accept the Arctic Gas thinking, that results in their chilling the gas to the 60th parallel, then you would have to chill throughout your feeder line system around Great Slave Lake as well.

A Well no sir, because there is no compression on that line which adds heat to the gas. The primary reason for chilling is when you do add heat of compression.

MR. SCOTT:

Q In short, it's your position that the gas on the Yellowknife feeder line will achieve ground temperature reasonably quickly?

A Yes sir.

THE COMMISSIONER: You don't need the compression because you're only taking a very small supply of gas compartively around Great Slave Lake, is that it?

A Yes, there is adequate pressure where we tap that line, to get to the furthest extremities of the pipeline.

Q I see.

MR. SCOTT:

Q Mr. Claridge, as I understand you then, the situation is this, that the solution to the frost heave problem is not without its risks, is that what you assert. You're not as confident as Arctic Gas?

A Well I think Dr. Hwang has commented that he's still working on his solution. I dont think he has presented the results. It's something that we're saying has to be looked in the future.

Q But Mr. Mirosh, I take it that if a solution is devised, the question of where you stop chilling then becomes simply an economic question as you have indicated?

WITNESS MIROSH·

A Yes, economics enters into it, it's not simply an economic question because one has to look at the effects on the environment and construction techniques, the manpower required to implement them and so on.

Q Yes but those last two are economic questions aren't they, construction techniques and manpower requirements.

A Well they could be that, they could also be one of availability of supply.

Q I would have thought was the economic question par excellance, but we'll leave that.

Now do I understand that if chilling is stopped at Fort Simpson, the result of that is going to be not that there will be less severe

frost heave problems, but that you will simply have reduced the mileage over which they will occur?

WITNESS CLARIDGE:

A If chilling is halted at Fort Simpson, the frost heaving possibility will not exist south of that point.

Q Yes, but what I'm saying to you is that that will not necessarily remove the worst frost heave problems, it will simply reduce the number of miles over which you will be confronted with them?

A Inasmuch as there is other unfrozen terrain to the north of Fort Simpson, that's correct.

Q Right, so that by stopping chilling at Fort Simpson, you have not removed a frost heave problem of any particular dimension because it will exist north, you have simply reduced the number of miles over which you may have to apply solutions?

A That's correct, if the solutions involve a considerable expense let's say, then that expense would be reduced by selecting a point of allowing the gas to be warmed.

Q Now, Dr. Hwang or indeed anybody else who wants to contribute to the next question, from your studies, what is your concept of the worst case of frost heave conditions that the Foothills pipeline may have to contend with. Now what I'm looking for here really is a list of characteristics, in terms of terrain character, soil type and so on.

WITNESS HWANG:

A You can let me just confine myself to the magnitude of the heave without getting into other aspects of the problem, like drainage and slope stability then I would say it's a silty material is the worst.

Q Is there any other factor that you want to add?

A We are talking about within the temperature range.

I would say it is a matter of probability that it is near the silty material.

Q Mr. Claridge or Mr. Davison, are there any characteristics of the profile of this worst case that you want to add?

WITNESS CLARIDGE:

A I apologize --

Q Of water table?

A -- I wasn't listening.

WITNESS HWANG:

A I forget to say that, that water table too, but I took that for granted.

Q What I am trying to establish is the worst case for frost heave, and to develop a profile of the conditions that will exist in that worst case, and Dr. Hwang has added soil characteristic, and he refers to silty soils, if I am correct, and I take it an accessible water table?

A That's correct.

Q Have you, as geotechnicians, any characteristics you want to add to that profile?

WITNESS CLARIDGE:

A No sir.

WITNESS HWANG:

A Could I add this? I took too much for granted, but I would like to explain to you the range we are studying. Soil characteristic depending on the suction pressure. Water table determine the supply. At the same time we have also to know

the soil stratigraphy. I may have a silt which may be only 10 feet, and below that I have a till, which is a highly dense till, then I may not have frost heave there, so I can only give you the overall, but it is actually when you come to predict the magnitude, the soil profile is -- you have to consider the overall, and at the same time you know -- you have to estimate how far the frost bulb is going down.

Q All right. Well within that profile of what I take it now to be four characteristics, what is, if there are no remedies applied, the maximum heave that you may have to contend with?

A The maximum heave is automatically resolved, the soil profile, in addition to the other conditions.

Q Well taking the worst case, what is the maximum heave, if there are no remedies applied?

A No what applied?

Q No remedies, no overburden, no -- if none of the solutions suggested by Foothills and Arctic Gas were applied in this worst case, what is the maximum heave that may be contemplated?

A I think you are asking me about what is the maximum heave you can ever occur.

Q Right.

A I cannot give you that as a definite answer. I have to know more material properties, in order to give you that answer.

Q Well, are you able as a

result of your studies to date, and related to this line, to tell us the worst case and the maximum heave, or is it too early to ask you to do that?

A There is a distinct principle for doing that, but I haven't worked out the number.

I would like to give to you a little bit mechanism of the heave, it may be a little bit out of the pipeline temperature range, but if I give you a uniform silty material, that I freeze as fast as I can, I may not get no heave except in situ water change. So when we come to estimate the heaving, we have to consider that, am I right?

Q Well no, because you are putting a best factor into the worst case. You are adding --

A No, what I am saying is I have to go through those mechanisms, knowing the freezing rate, but because the heave is coming out from the water migration pore at the front, and it took time to get there, so we have to go through quantitative evaluations over that time, over that range of pressure, how much get in, but at the moment I know there are other ways, and principles applying to it, but I don't have a number to give you that.

Q No, but I take it that in approaching problems of this case, of this type, geotechnicians frequently develop a profile and an analysis of the worst case, to see what they may have to contend with if as occasionally happens, worst comes

to worst. Isn't that a legitimate approach?

A Yes, we usually establish worst first.

Q And do I understand then, that you are not able at this stage, at this point in time, you have only been at it six months, that you are not able at this point in time, to give us the worst case and the worst results with which you may have to contend?

A This is not ever inability.

Q Well I know you have the ability.

A I have to have a number--

Q All right. When I say not able, I put it this way, that you haven't got around, you haven't been able to get around to it yet?

A Yeah, I don't have a number yet.

Q And I take it that that work will have to be done, the establishment of the worst case, before one can gauge the extent to which or the type of solutions that can be applied?

A For my own part, yes, I have to have a number before I can make recommendations to the management.

Q And do you agree, Mr. Claridge, that the worst case has to be profiled before the measure of the solutions can be accurately assessed and applied?

WITNESS CLARIDGE:

A Well I think sir, there would be enough information available at this time in the north that one could assume what the worst conditions would be and work on that.

Q Well what do you assume they are then?

A I think Dr. Hwang expressed that adequately.

Q But he said frankly that he was unable to give us the worst case because he hasn't been able to get around to it yet.

A He mentioned the silt and the high water table, and I would suggest a loose condition which could be in the context of soil property.

Q Yes, but what I was asking him to do, he listed the conditions as you did. I was asking him to predict the heave that might result, and he says he'll be doing that, but he isn't able to do it yet, and he agrees that that's the appropriate approach to gauge and measure the solutions. Do you agree with that?

A Yes.

Q And I take it that you are in no position at this stage, to give us the heave potential of the worst case?

A We certainly would make available all the data that we have on the project, including that 100 miles south of Fort Simpson, so I think that Dr. Hwang would be provided with a reasonable

data base.

Q He's not able to make the prediction as to the worst case, apart from the factors that make it up, and I take it it's clear that you are not either?

A I think both of us together could do that.

Q Could do that, but haven't done it, isn't that fair?

A No sir, it's not been done.

Q All right, and I take it that you have to do that, as I think Dr. Hwang says, before the extent and the scope of your solutions and remedies can be measured?

A Yes.

Q Yes. Now I take it, Dr. Hwang, that precisely the same problem occurs with respect to measuring the worst case of thaw settlement, except in reverse?

WITNESS HWANG:

A The thaw settlement will be much easier.

Q It will be easier to do?

A Because we know the -- from the experiment data and the past experience, to know the settlement, it's much easier than frost heaving.

Q All right. Well I take it that again what a prudent geotechnician does there as you put it, is he begins with the worst case and he

predicts the conditions that will create the worst case the criteria for thaw settlement? Is that correct?

A I lost you.

Q I'm sorry. When you come to thaw settlement, again you make a profile of the worst case?

A That's right.

Q Yes, now have you done that yet?

A I haven't done that, but if I have soil data with me, I can roughly give you the number here.

Q Well can you predict, I don't have the soil data, but can you predict the worst case result in terms of thaw settlement?

A Oh yes, yes.

Q All right, what settlement are we looking at?

A Depends upon the ice content, and the compressability when the permafrost soil thawed, and we measure in the lab, only thaw trends, that is the boreing change from a frozen state to thawed state and you intergraph from the bottom of your thaw bore up to the surface and that will give you an approximate number.

Q Well I understand I think the technique, but have you measured the worst case yet in thaw settlement?

A You mean have I actually

had a pencil and calculated a number yet?

Q Have you gauged the worst problem in terms of thaw settlement that you will confront?

A I don't have, I haven't come into the element sheet and getting the soil, so I have not calculated the actual number.

Q Yes, that is something again that you will have to do?

A Yes.

Q Yes, and Mr. Claridge, do you agree with that?

WITNESS CLARIDGE:

A Yes, I do.

Q Yes, and I take it that it is only when you have gauged the worst case, and its extent, that you can measure the adequacy of the solutions or the extent to which those solutions are going to have to be applied? Is that correct?

WITNESS HWANG:

A Yes.

Q I think the answer was yes, was it Dr. Hwang?

A Yes, I have to know that.

Q Well now, in your transcribed evidence, I think Mr. Claridge or Mr. Davison, and I don't have a note of it, but you refer to a solution for thaw settlement problems, and you refer to the installation of pipe supports. I'm sorry, that's in the evidence of the design panel, the design panel

has said that one of the solutions or the solution for thaw settlement is going to be pipe supports. As geo-technicians are you aware of, or are you contemplating of any other remedies for thaw settlement?

WITNESS DAVISON:

A Yes, there would be other contingencies that would be examined.

Q What would the other remedies be, or contingencies, if you want?

A One such device would be replacement of the offending soil with suitable granular material that would not be subject to that effect.

Q Any others?

A As mentioned in our application, one might also consider perhaps other types of construction, perhaps a berm construction, but this has other implications that are unevironmental regards, mainly that would only be considered.

Q How about drainage solutions?

A That's what I'm referring to, that we were concerned about a berm construction for that reason, that we do prefer to be underground.

Q How about injection of other substances, such as cement?

A No sir that's too tricky.

Q Are you doing any -- I raised these questions because as I understand that thaw settlement is not going to be something that Arctic Gas appears likely to have to confront, but you may. Are you doing any studies on the applicability of these solutions to thaw settlement?

A Not at this time other than in thinking about it.

Q At what stage do you intend to be able to produce a range of design solutions. I'm not asking which solution you're going to apply at which place.

WITNESS MIROSH:

A Well as Dr. Glockner pointed out earlier, he is carrying out stress calculations for both frost heave and thaw settlement. Dr. Hwang is

carring out geothermal applications, and at the point where we can match these two curves and see if we have a problem and to what degree, then we will be entertaining solutions.

Q Well what time frame are we talking about. It's the solutions we're interested in.

A Well of course, this is preliminary work but I believe that Dr. Hwang has indicated that he will be ready with his model, shortly, and Dr. Glockner has indicated to you that he is at a point where he is close, as well. If you want a specific date, I can't offer that to you right now, but we're aiming at having this material to a point before the National Energy Board.

Q That means October 29, does it?

I'm being facetious.

MR. GENEST: They have to show their reserves first, it may take a long time.

MR. SCOTT:

Q Mr. Claridge, I'm instructed that the operation of a warm pipeline on sloping permafrost sites where there are fine grained soils, may lead to special or unusual problems of stability and of drainage and erosion control. Did you agree with that observation?

WITNESS CLARIDGE:

A Yes that is correct, but I might make the observation that south of Fort Simpson, the slopes are quite gentle and generally not of a

condition that are prone to failure in the route that we're considering.

Q Is it your view that that problem will not arise south of Fort Simpson?

A I don't feel it would be a significant problem.

Q Aren't there south of Fort Simpson any river banks that might fall into that category?

A That might fall sir?

Q That might fall into that category?

A There are one or two or three rivers, the Trout River, the Tekesa River, are two that come to mind. They're rather straight forward ones. I believe the Trout River was drilled during our investigation. We found it was essentially sand and gravel at the location chosen,the banks are stable, and we foresee no problem in crossing.

Q So you don't anticipate that the problem I have described or tried to describe will occur south of Fort Simpson or at any of the river banks south of Fort Simpson?

A Not at the river banks and not to my knowledge, as a real concern along the main route.

Q Mr. Spafford, in question 47, on page 20 of your -- you provided a discussion of the input data for the design of erosion and drainage control devices, as I understand it, and suggested that

analysis was based on studies in sample areas. Have I got it right?

WITNESS SPAFFORD:

A Correct.

Q Then you referred in the text to a slide which is going to show us something about sample areas I think. What happened to the slide. They are the highlight of my day at the Inquiries.

A The slide was not made up since I was called to this hearing somewhere between midnight and one o'clock Tuesday morning and was asked to be here immediately afterward.

The slide was a victim of that.

Q The slide not being available, I'm going to have to ask you some questions about the sample areas. First of all how many were there?

A So far there have been two. We are now analysing a third.

Q Can you tell us where they were?

A I would defer to Mr. Davison or Mr. Claridge on that because---

Q Did you not select the sample area?

A No, I didn't select them, they selected them.

Q Who on the panel, if anybody, selected the sample areas?

MR. DAVISON:

A Mr. Gillespie and I were involved in the selection.

Q I see, can you tell me where they were?

A If you want a detailed list, I shall give you one.

Q I take it that there were two, that Mr Spafford got.

A Mr. Spafford has worked out the hydrology of two. It believe it may not have been himself, another member of his firm I told that we had a total of six that we would be transferring when we had them in presentable form.

Q Well he has worked out two now has he?

A Yes sir.

Q All right, where are those two?

Q They are in the -- they're on a drawing.

A Can you through your counsel, provide that drawing of those two sample areas to us?

A Yes, we could.

Q Can you tell us from recollection how large they were.

MR. HOLLINGWORTH: Do you want the drawings or do you want to wait for the slides?

MR. SCOTT: I don't care. If

this information is shown on the slides, it may not be. I want to know the -- where the sample areas were, how big they were and a number of other things about them.

A These are shown on drawings which I have with me.

Q Who selected them, was it you and Mr. Gillespie?

A That's correct.

Q How did you select them? What were the criteria?

A Our approach in selecting them was to identify a suitable variety of drainage and terrain conditions along the pipeline route. We attempted to let's say select the full range that we feel/we would be dealing with in final design. Our approach there was to develop our methods within those areas that we felt could be extended in the final design stage to the rest of the route.

Q And referring to the two sample areas, what work was done at each, then?

A This work consisted of traversing through an area which extended roughly a mile or a little less thana mile along the direction of the pipeline and up to one or two thousand feet to either side of the pipeline. There was a -- there were a series of lines that were probed for --

Q What do you mean probed?

A Probed, by that I mean the active layer thickness was established at quite a large number of points, drainage courses were identified,

where there was water, the amount of flow was estimated where there was not water, but evidence of seasonal flow, the size of the courses were measured. In addition, there were permeability tests done in the active layer and we also measured slopes and with the permeability and slope data we were able to estimate the flows in the active layer.

Q What time of year was this sample prepared?

A This was done in the mid spring season, late May and June, after the snow melt had occurred.

THE COMMISSIONER: Mr. Scott, would this be a convenient time to adjourn?

MR. SCOTT: I have just one question.

Q How could you measure in a meaningful way the active layer in May and June.

A I didn't hear your last words?

Q How could you in a meaningful way or significant way in this, God's country, measure the active layer in May and June?

A With a metal probe. which is about a quarter inch thick that you push into the ground until --

Q I know the techniques but what I'm saying is, in May the active layer as far as I can judge ain't so active around here.

A Why do you say that?

MR. SCOTT: I'm ready for lunch.

A Have you got some records that we should have.

THE COMMISSIONER: Well we'll adjourn till two.

(PROCEEDINGS ADJOURNED UNTIL 2:00 P.M.)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. SCOTT: Mr. Commissioner, Mr. Hollingworth has produced, under the title "Foothills Pipeline", two drainage study area maps which I take it are the ones referred to by Mr. Claridge and Mr. Spafford. They are drawings Number D0565-B, and drawing D0565-C. I have suggested to him and I think he prefers this, that he should take them back and have copies made which can then be marked as exhibits in due course, if that's satisfactory.

THE COMMISSIONER: Right.

CROSS-EXAMINATION BY MR. SCOTT, CONTINUED:

Q Mr. Claridge, with respect to these two drainage areas and the manner in which they were chosen, and analyzed, by what method do you intend to extrapolate from these to the pipeline as a whole?

WITNESS CLARIDGE:

A First, I wish to correct an impression which I may have given you before lunch. We were measuring what is known as the active layer during the springtime, that of course is not true. We were simply measuring the depth of the thawed material.

We are looking at the drainage sites in terms of several seasons. We are presently probing them, and examining the presence and distribution of water and comparing the effect of season on

drainage.

Q So would it follow from that that the sample area maps therefore had no information whatever as to the active layer?

A Yes, the probed depths of the thawed zone during the springtime are given on the maps, and an estimate of flow through that thawed layer is also presented on the drawings. This is a portion of the active layer.

Q Yes, but that doesn't tell us anything about the depth of the active layer.

A It tells you the thawed thickness of the active layer at that time of year. The active layer is in your terms, the maximum thawed depth which is achieved towards the end of the summer, and this will be measured and when those results are in, they will be incorporated on the drawing.

Q It certainly tells us the minimum active layer, that's what you are saying?

A That's correct.

Q Not the maximum active layer.

A It happens to be a more critical condition as water is forced up to the surface at that time of year, so it's a relevant condition.

Q Do you think bearing that in mind, that the data on those sheets is really particularly useful and something from which you can generalize?

A It gives us a base. It

tell us what are the conditions in the springtime, and we will soon know what the conditions are in the late summer, and it's important to know what is the drainage situation really like, and from that we can begin to contemplate the effects of the pipeline.

Q Well now, how do you intend to move beyond these maps to the pipeline as a whole? How do you intend to generalize from them?

A Through our multi-disciplinary studies by liaison with the environmental people, liaison with Dr. Hwang, Dr. Yip on thermal matters, and through our own continuing studies.

Q Well I'm not quite sure what that means. I know that the panel and those behind it are going to be meeting constantly over the next months or years, and talking about a vast variety of subjects. The problem that I ask you to direct yourself to, is having done the work on these two sample areas, by what process do you intend to generalize from that limited analysis, or analysis of a limited area, to anything that will be meaningful with relation to the pipeline as a whole?

A Well I have said that we would be developing methods of design in the -- I referred to six areas, and we are extending that to nine, because we are concerned that we didn't have a sufficient variety of conditions under study. Now we feel we are identifying the range of conditions and we will be establishing methods within each area, and we feel the methods will be applicable at other locations

along the line.

Q And when you say you will establish methods within each area, what are you talking about? Drainage control devices?

A Yes, drainage techniques and erosion prevention.

Q And I wouldn't overstate it if I said that that process, and those techniques and designs, are substantially ahead of you, work to be done?

A Yes, that's correct.

Q Now, with respect to these and maybe I'm asking a question that it's impossible to answer in the present state of the knowledge that you have, but when you have devised your methods, how are you going to plan for them? Are you going to lay them out on the alignment sheet and say do this here, do that there, or what are you going to do?

WITNESS DAVISON:

A It's a scale condition that bothers us right at the present time. The alignment sheets are, I believe they are about one inch equals 2,000 feet. At this time I do not believe we can get the detail on such a sheet. It may be necessary to, in the final design, to rely upon notes and actual chainages along the pipeline with respect to the final design.

Q Well perhaps I haven't understood. I take it that the purpose of the sample areas, whether it be two, six or nine, is to give you

a range of areas which will enable you to understand the drainage workings of that kind of sample area, is that correct?

A That's correct.

Q Yes, and from that you will be able to devise with particularity, the methods that are suitable in that type area?

A That is correct.

Q Yes. Well now, having got that, how are you going to plot the utilization of these techniques along the right-of-way? Is it going to be done by mile-by-mile analysis of the route? Is it going to be done by some kind of manual, or is -- what is the technique going to be?

A A manual will be prepared with respect to the techniques that can be produced, and the application of that manual will be on a mile-by-mile basis.

Q So that the construction people will be able to look at a manual and will tell them at Mile 300 and a half what to do. is that what you're suggesting?

WITNESS DAVISON:
A The manual that I'm talking about will be the techniques, the design, which the construction people will make reference to certain sections of that manual, for drainage or erosion control. That is how we're envisioning it at this time.

Q What I'm concerned about in connection with drainage and erosion control devices, is whether the selection of which technique to use at which place is going to be made by geotechnicians or is it going to be made by construction people in the field?

A I would assume sir that this design will be done by geotechnical people.

Q So that at the end of the process, I take it there will be clear instruction for the construction people as to which device is put where and how?

A The design would be done by geotechnical people yes.

Q No discretion,

A I don't understand.

Q It's not going to be a matter whereby the construction people, as they come upon a particular situation, select from a range of options.

A There would be, I would

envision, during construction, if conditions should change upon opening the pipeline, there is also considered a change manual if you wish to call it, that would comply with it and that it would be on site decisions with the engineers and the construction people, that would take this into account.

Q Now I think I understand your criticism of the -- leaving aside whether it's right or not, your criticism of the alignment sheets of Canadian Arctic Gas, but surely the Foothills alignment sheets are going to give instruction on drainage and erosion controls and conditions?

A I'm not sure sir. Could you just repeat this. I have indicated that the detailed design, I feel that the scale of the mosaic sheets may be too large to give sufficient detail. I am not too certain as to whether you're feeling is that a tentative design should be placed on these alignment sheets.

Q I understood your criticism, of the Arctic Gas alginment sheets to be that there was shown on them, drainage and erosion matters.

A That is correct.

Q Now was that criticism one of principle or that the the scale of the map was too small or that the information was preliminary?

A That it appeared to be a tentative design that may not actually be used in the field because of the scale considerations.

Q I take it that what you would recommend to them is that they should up date from

time to time their drainage and control information and modify their alignment sheets accordingly?

A Providing that they're able to get the detail onto that scale, yes.

Q And I take it that you will be doing exactly the same, providing on your alignment sheets of whatever scale you use, drainage and erosion instruction?

A At this time I can not really say that, we have presented you with drawings, sir, that have the information on it, at a much larger scale, and we have not seen whether we can get that down to, the detail that we want down to a mosaic sheet.

Q Mr. Commissioner, I would just like to confirm so we will have it that the drainage study area maps that Mr. Hollingworth has provided and which will ultimately be exhibits, appear to be at miles 311.3 and 536.9.

Mr. Claridge in answer to question 31, you have stated as I understand, that you have determined that the method of treatment of defined drainage courses, will apply equally well to the surface portion of the sheet flow. Now, I'm instructed to ask you how that was determined.

WITNESS CLARIDGE:

A Our consideration is that as I stated that sheet flow is really --it's a poorly defined term, it's not well understood but our impression from seeing the sheet flow is that it really is a combination of poorly defined stream channels most of which are

seasonal in nature and that the vast bulk of the water would be carried through defined channel that could be treated with breaks in the same way as, let's say, active streams.

Q Well apart from being a matter of general impression, is there any literature which supports that theory, or any study that you have done yourself?

A Well these studies that we are doing which will ultimately be reported on, will support this view. To our knowledge, there is no other similar study available.

Q Well perhaps we just better wait until you are able to report, so we will then know for certain that that's what the report reveals. I take it that the work is still underway?

A Yes, we are just now finding out how deep the active layer is.

Q No, but on this subject, the work is still underway, and aren't you being rather aggressive, perhaps, in reporting the results of it before it's --.

A All right then, we won't report it.

Q In other words, what this is is an impression, and you anticipate the impression may, but I suppose also may not be proved out by your studies?

A Well this is our considered opinion, that this will in fact be the case. We don't have to/actually have to have it all written down before we make up our mind. Usually we know in advance what we are going to say in our report.

Q You don't know surely in

advance of your analysis of your studies?

A No, but the studies that we are doing now are largely of a confirmatory nature of what we did in the spring, and I think we know pretty well what to expect.

Q And I take it that you will be providing in due course, and maybe if that's the view, there's no hurry for it, some detailed report of this?

A Yes, I'm sure Mr. Mirosh would expect that.

Q Then in question 31 also you say "the portion of flow occurring in the active layer has been determined to be a small proportion of the total flow." Is that again an impression that you anticipate will be fortified by your studies?

A This is based on a spring run-off condition at the time that studies were done. Of course, this figure will vary throughout the year, according to the thickness of thawed material and the amount of runoff and the actual percentage will vary, but it is our opinion that it will be a small percentage of what I consider run-off flow, as advised by Mr. Spafford.

Q Well I suppose in the spring even I might have hazarded a guess that that was the fact. What about the fall?

A We're studying that at the present.

Q I take it that this

statement either has no application or has not been fortified by any data with respect to any period except the heavy spring water?

A We have an early indication of the maximum thickness of this layer in the northern part of the route. We do have these numbers. There's not a great difference in that value, but our program is proceeding south and we will undoubtedly have different observations there.

Q And I presume --

MR. GENEST: Excuse me, Mr. Scott. I don't think we got an answer to the question you asked.

MR. SCOTT: Well we -- I take it that the witness agreed with me that this observation, while it might have some application to the spring, didn't -- had no application in any other season of the year.

A I'm indicating that the observation or the statement I think will be confirmed in the northern part of the route, and I'm saying that I don't know in the southern portion.

Q So again it's a good professional guess, about what the data and the studies will reveal?

A It's our considered opinion, yes.

Q Well yes, but it's an opinion like so many matters, in which you feel sufficient risk, that you feel obliged to do studies?

A Yes.

Q And these studies aren't to confirm something you already know, they are to find out something that you don't know, aren't they?

A Correct, but when you are half-way or three-quarters of the way through, you tend to develop an opinion as to what you are going to discover.

Q Well it may be then that engineers are not so different from lawyers, as I thought.

MR. GENEST: I hope they are different than judges.

THE COMMISSIONER: It's getting too deep for me.

MR. SCOTT:

Q Well now in question 32, Mr. Claridge, and I'm tentative about asking these questions, and you tell me if I am too premature in the kind of questions I'm asking because I don't want to get into the subject if no firm views have been established, but in question 32 you discussed the control of water near the pipeline, and you refer to mound breaks, mound and mound break protections, special protective devices on slopes, diversion mounds or ditches and revegetation and so on.

Do you know of your own knowledge, or from the literature of any examples of places where mound breaks similar to those you contemplate using, have been successfully used?

A I believe that they are in application on the Alaska Pipeline, but I would have to refer that to someone who has actually been in the last two or three months.

Q Well you've heard they're in use on the Alaska Pipeline. Do you know anything about how they are used in the Alaska pipeline, how they have worked, what the consequences are?

A I don't have first-hand knowledge of the results of their work, but we shall be endeavouring to contact them about that.

Q Well then I take it that you don't really present this as a solution to the problem. What you're basically saying with respect to mound breaks of this type at least, is that we've heard that they've been used in Alaska, but we don't know what the results have been?

A That's correct, but we feel that this is the best approach to passing cross drainage.

Q Well surely you don't proceed on any theoretical basis, you want to get data to prove out any preconceived theory?

A That's our intention, and our intention is to provide the minimum disruption to observe drainage courses and by providing an interruption in the mound, we feel that this is the least disruptive way and leaving the condition after construction as close as we can to what it was beforehand, so we think that this is sound.

Q Well you say that it's the least disruptive way, and I take it that that's a theoretical conclusion because you haven't seen any. I'm sorry.

A Not entirely, I think there are highways that one could observe stream crossings. They're not entirely the same, but I think one could also look into pipeline construction in the south. I think Mr. Mirosh could comment on that, and I think there's some application to that experience.

Q Well let's see what is known about whether they're the least disruptive way. What do you know, and I say know, about the effect of frost heave or thaw settlement in these breaks?

A I would refer that, for first crack anyway, to Dr. Hwang.

Q All right, Dr. Hwang, you're going to tell us about these mound breaks now, and I don't know whether a computer is going to help you.

WITNESS HWANG:

A I haven't tried to do that yet. I do not have a number to report.

Q All right. Well, Mr. Claridge -- I'm sorry, finished Dr. Hwang? Did you finish your answer?

A Yes, that's right, we have discussed this in Foothills' office with Mr. Claridge, but we haven't gone into a detailed analysis of it yet.

Q Well back to you, Mr. Claridge. What do you tell us? The thing that troubles me is that it's one thing to say, as perhaps you intend to, that we don't know what the solutions are to this, but here is a hypothetical concept which may work, and we will watch it carefully and analyze it and all the rest of it. But to suggest that this is a design that will not be disruptive, is that fair in the present state of your knowledge?

WITNESS CLARIDGE:

A I'm sure that from the point of view of integrity of the pipeline, frost heave will be given extremely close attention, that these predictions will have to be soundly valid. I think this was gone into in the design panel and earlier, and that in addition, of course, the crossing of drainage is a factor in that.

Now, one solution that we have talked about is where a heave situation is foreseen, that the pipe would be buried at a deeper level, and that there there would have to be surveillance of the pipeline during its operation. I can foresee having to repair breaks, perhaps to correct them if there is a heave situation. The mounds themselves, the mound itself may have to be altered. I look at this as to a fair extent, an operation and maintenance surveillance problem.

Q Could we put this -- we developed a category in dealing with the design panel, that I think Mr. Mirosh suggested, that it was an idea on the back of an envelope. Could we put this particular idea into that category at this stage?

A Well, it would be, I think earlier than that.

Q Earlier than that?

A Well earlier than a day or two ago. We are certainly aware of the problems and we have considered all the time that we would go to design procedures to remedy problems of heave and drainage and other items and we are embarking on those designs. Perhaps we could even argue they're final design problems, but we don't. We say that we are developing methods and we are in the midst of that. We are collecting our data and I wouldn't say that it's -- well you can see from the drawings, that's bigger than an envelope.

Q Are you familiar with the expression horse tail drainage?

A Yes, I've heard of it. I'm not sure I could explain it as well as you though.

Q Well I'm not sure that I could have explained it before last night at all but I take it that that refers to a situation in which there are very many shallow ill-defined channels in close proximity on a side hill area, do we agree that we're talking about the same thing?

A That sounds reasonable.

Q How are you going to deal with that. Have you given any thought to that?

A Well poorly defined drainages, I think this is exactly what we've been studying. We have been undertaking study areas on the flanks of hills. I use the Ebbutt Hills as one example where there is just this type of drainage. I think it's very similar to sheet drainage and we would go back to our principle of controlling individual depressions, swells as we see them, providing the breaks where we anticipate flow to occur and this would be very heavily oriented on a field, walk over survey.

Q In terms of spacing how frequently is it practicable to construct mound breaks?

A In the areas that we have looked at, the spacings are quite variable, depending on where the drainage courses are. I think in the two areas that you have, the minimum would be perhaps 50 feet, 40 feet, something like that, and the maximum might be 300 feet and that might be arranged.

Q Is 50 feet then the minimum limit of practicability?

A No sir.

Q Well what is.

A The width of a break that we've tentatively chosen is eight feet, so if one had to, it would depend on the size of drainage course. The break itself could be made wider, as much as necessary to pass whatever water there is, and then they would be as frequent as the drainage courses.

Q So it's not impractic in your judgement to place them end to end along the pipeline. Obviously there is a cut off point isn't there, where a solution ceases to be practicable.

A Well we would not foresee that that extent of break as being necessary. I think in the examples that we gave you the range there, I should suggest, would be a typical one.

Q You also refer to what you call special protective devices.

That sounds like an advertisement just there, but you speak of special protective devices to be used to control water on steep slopes.

What is intended here?

A Where is the reference, I'm lost.

Q It's question 32, paragraph -- no, it's not. The bottom of page 14, you've dealt with the conventional measures, I say conventional in the sense that I think Arctic Gas has referred to them too, the preceding measures will be applied routinely on all drainage courses, in addition special protective devices will be used to control water on steep slopes crossed by the pipeline. And then you refer specifically to stilling basins, let down structures, or baffles. Now, first of all, I take it that you anticipate that the previously mentioned devices that is A, B and C in paragraph 32 will not be useful to control water on steep slopes.

A They would be useful but they would not be the sole protection.

Q They wouldn't by themselves do the job?

A Depending on the steepness of the slope and conditions of the ground.

Q Now when you refer to special protective devices, did you have in mind anything else but the ones that are set out following that sentence?

A Those are the ones that we are considering at the moment. I'm sure there will be others that develop during further studies.

Q I'm sorry. I didn't catch that. There will be others?

A I would not wish to state that there would not be since our studies are only partly complete. In response to your previous suggestion, I'm sure we wouldn't pre judge at this point what measures would be needed. There may be others.

Q So that you will examine the efficacy of these methods and you hope as you go along some others may occur to you?

A I'm sure they will.

Q Now in the last paragraph of Question 32, you say emphasis will be placed on the use of types of erosion protection which will serve both to stabilize the soil back fill and disturb terrain adjacent to the pipeline and also to encourage the early formation of new vegetation. The applicant is also commit-

ted to undertaking safeguards which will minimize the degree of disturbance to the terrain. Now, when you use the expression types of erosion protection, I take it that you are simply referring back to the ones that you have mentioned previously. You weren't referring to some additional ones?

A Yes sir, that's correct.

Q All right. so that at the moment at least is the limit of the erosion protection devices that you have in your repertoire?

A Yes sir.

Q Well then, what is the meaning of this last sentence "The applicant is also committed to undertaking safeguards which will minimize the degree of disturbance to the terrain. From a geo-technical point of view, I'm not quite sure what that implies for us.

A That refers to construction I believe that would be handled in the following panel. Perhaps Mr. Mirosh would have a comment on that since he'll be on it.

Q We will no doubt deal with it on the other panel, but this is your evidence and I really don't know what to make of that statement. frankly. Is it -- are you contemplating as a geo-technician that there are other safeguards within the knowledge of your geotechnical competence which must be taken or are you making some kind of motherhood statement about doing a good job all round?

A There would be definite

procedures followed in construction to counteract possible disturbance to the terrain. For instance, the use of Arctic construction techniques.

Q Are you giving advice on that?

A I'm sure we would be advising Foothills on that, yes.

Q Well just in point form, can you tell me what sort of thing you mean.

A For example, in an ice rich terrain, it would be necessary to minimize disruption of the root cover. For instance, one might try to ensure that the roots are not torn up, might use hand clearing or special machines that do not cause a disruption.

Q Have you had occasion to give advice on these matters as yet to any members of the construction panel?

A Myself, I have been involved with Mr. Speer and with Mr. Davison of our company in giving just this sort of advice, yes.

Q So I take it that they will be able to tell us in due course, what you have advised them, with respect to these matters referred to in that paragraph?

A They have our advice.

Q Is it in written form?

WITNESS MIROSH:

A Perhaps I can help you out here, Mr. Scott.

Klohn Leonoff, along with the other people on this panel and others, have been in various meetings with Foothills' people, construction people, pipeline design people. They have contributed opinions in these meetings, advice in these meetings, and they have had it counteracted in some cases, and in general it has been a give and take to determine methods that we would use for construction, for clearing, for operations on the right-of-way. This material will be in written form, primarily it's material that we are developing in answer to any B deficiency questions as I'm sure is CAGPL, and it will form part of our application at a time in the future when the N.E.B. feels free to make it public.

Q Well are you suggesting

that there is information which you are making available to the N.E.B. on construction safeguards that you are not prepared to make available to us?

A No, we are certainly prepared to make it available to you, but we are trying to meet an N.E.B. deadline to produce it for them, and I'm sure at the same time that it will be available.

Q I see. It doesn't yet exist in any written form, that's what you are saying?

THE COMMISSIONER: You are not prepared to present it yet to anybody, is that the point? It hasn't reached that stage, is that it?

A Well it is very close to that stage since we are trying to meet a deadline for the Energy Board, but it's not at the final stage to date.

MR. SCOTT:

Q Well let's come back to my question of Mr. Claridge. Mr. Claridge, have you in written form given any advice to construction people about what you call these safeguards?

WITNESS CLARIDGE:

A It is the same as Mr. Mirosh referring to that we have assisted in preparing responses to N.E.B. deficiencies, and that's what we have done.

Q Well would it be correct to say that you have provided to Foothills, written advice on these safeguards, whether they have filed them in final form or not, it is out of your hands?

A We work a little differently perhaps than you might understand. We are often with each other at meetings and sometimes we chop and we put together one man's statement with another, and that's really how it was done. We are working, a number of us together, both Foothills and the consultants, and in view of the time we have not issued any separate report, no.

Q Well I take it then that the construction panel won't be able to tell us about them either, is that correct, Mr. Mirosh?

WITNESS MIROSH:

A No sir, I think we will be able to discuss these methods. I'm not sure if there's a question here which counsel should be giving some thought to, if we get into any B deficiency questions, and whether they should be brought out here.

Q Well before you induce Mr. Hollingworth to rise to his feet, my concern, Mr. Commissioner is this, that these safeguards Mr. Claridge has told us, and they're obviously important, they are highlighted in his evidence, are safeguards that are to be implemented, as I understand it, by the construction people, and they are provided by a qualified geotechnician.

There isn't going to be any geotechnicians I understand it, from Klohn Leonoff on the construction panel. If I don't find out what the geotechnical advice on these safeguards is now, I won't be able to find out later unless there is some undertaking

to provide it.

WITNESS CLARIDGE:

A I wouldn't wish to create the impression that it's really terribly different from what has been presented in the evidence provided by this panel. It's along the same lines, perhaps with some different wording.

Q Well perhaps I misunderstand, but the whole thrust of question 32, it seems to me, is directed to solutions to drainage and erosion problems. There is some limit, perhaps, in the understanding of the application of those solutions in given cases, and you say as sort of a wind-up at the end, Notwithstanding all that, there are certain safeguards which we are going to implement in construction, so that if we don't catch it this way with these safeguards will certainly save the day for us.

Now, can you tell me what they are? Is there some manual I can refer to? Is there a list? What are you promising to do here that will reassure us?

WITNESS MIROSH:

A Well the sort of things that we would consider undertaking are, for example, defining where sensitive permafrost exists, sensitive permafrost being what we have gotten to call "fine grained ice-rich soils". Taking measures to insulate the vegetative mat by snow during the construction phase if we have to go through those areas, not clearing those areas until the last possible moment of

construction, using low ground pressure vehicles where we can. This kind of remark I'm sure is intended in Mr. Claridge's statement, but I guess I feel a little uncomfortable speaking to his evidence. I assume that is what he had there.

Q Well Mr. Commissioner, the difficulty and I won't press it much further, is that one of the functions of the Commissioner is to, as I understand, is to make recommendations as to terms and conditions. We have been told now that the applicant is committed to particular safeguards above and beyond the erosion control devices and so on he has referred.

I think it would be useful to know, engaging the recommendations that you may want to make, what those particular safeguards are. I offered Mr. Claridge the opportunity to say, well this was just a motherhood statement that we were going to do as good a job as we could. He declined that, and I gather there are a specific number of safeguards that are contemplated.

It seems to me that in written form, I am entitled to know what those are, respectfully.

MR. HOLLINGWORTH: I don't think anyone said that you are not entitled to them, Mr. Scott. It has been said that these solutions are being put into written form in National Energy Board efficiency letters. This panel has expressed some apprehension about producing these prior to them going

to Ottawa. Frankly, I don't know if that's a valid concern or not. I can certainly check and let you know, but I don't think we have any objection whatever to producing them in written form when they are in written form.

MR. GENEST: Why don't you remove motherhood from your invitation, Mr. Scott? It might be more effective.

MR. SCOTT: Well perhaps, Mr. Commissioner, it could be left this way.

I take it that Mr. Claridge, I'm not interested in the construction panel at the moment, but that Mr. Claridge will in due course let us know in written form, what safeguards he contemplates with respect to this paragraph. I'm in no hurry for that, if it is desirable to wait for some weeks, that's fine too. But I would like it from him as a geotechnician, and I would like to reserve the right that we all have to ask questions about it, if it should be necessary.

WITNESS CLARIDGE:

A They would be identical to the safeguards that Mr. Mirosh just mentioned, that they are the ones that we have suggested to them.

Q Well nonetheless, I think if Mr. Hollingworth doesn't object, sir, I would like to have them in writing in due course because you as a geotechnician will stand behind them. Is there any objection to that, Mr. Hollingworth?

MR. HOLLINGWORTH: I fail to see how he's not standing behind them now.

MR. SCOTT: I'm not suggesting he's not.

MR. HOLLINGWORTH: I mean it's just another piece of paper which of course we can produce.

MR. SCOTT: I'd be grateful. I wouldn't be for my part so quick to regard it as just another piece of paper. I think it's an important matter and which I would like to pursue.

MR. HOLLINGWORTH: They've been listed for you by Mr. Mirosh and confirmed by Mr. Claridge. In due course that will be on a bit of paper which is the transcript. If you want me to produce another bit of paper, with them listed on it, fine I shall do so.

I'm troubled, Mr. Commissioner, by the fact that there has been incessant demands by my friend to produce documents which seem to be somewhat repetitious to what has been stated in testimony sworn testimony before you and this is well known. We have a job to do and a good deal of work revolving around various applications including one to the Department of Indian and Northern Affairs which you are considering now.

THE COMMISSIONER: I know that. I think though that the material that is being filed with the Energy Board should be supplied to the Inquiry. I would direct that it be supplied unless in the meantime you decide that there's an objection you wish to take.

MR. HOLLINGWORTH: I have no objection whatever to filing that material which in due course is to be filed with the National Energy Board. I understood Mr. Scott to be calling for something over and above that.

THE COMMISSIONER: Are you?

MR. SCOTT: WEll I think that will be satisfactory. It may be, Mr. Commissioner, I took this sentence altogether too literally and too seriously. What my concern is this, that there is a geotechnical panel that is in, as I understand it, in the course of recommending safeguards that relate to construction practices and which will supplement the drainage and erosion techniques of design that are referred to. In due course, I don't care in what form I get it, I would like to know what those are, in as precise language as I can have them. and I'd like to reserve the right to ask the applicants, geotechnicians about them.

MR. HOLLINGWORTH: May I just have a moment to speak to my client.

THE COMMISSIONER: We'd better wait for Mr. -- we're having a bit of a pause here I think.

MR. HOLLINGWORTH: There's another problem here, Mr. Commissioner in that while we have no objection to producing the deficiency letters to the National Energy Board, there is a time for their submission and as chance would have it, that's the same time constraint that the Canadian Arctic Gas is under.

We are in no way willing to produce our deficiency letters to anybody prior to the time that Arctic Gas produces theirs.

MR. SCOTT: Mr. Commissioner, I'm not determined to have a deficiency letter. I don't want -- I hope all of them will be produced and become part of the record here, but I'm not determined to have a deficiency letter in cross-examination. I'm asking the witness to specify what he means by these safeguards --

MR.HOLLINGWORTH: Which he has done.

MR. SCOTT: Well, which Mr. Mirosh has done and which he has said, all right, I accept that. Are those the safeguards we're talking about in their entirety, becauseif they are it seems to me that the sentence really has little impact.

MR. HOLLINGWORTH: That's a conclusion you're welcome to draw.
Why don't you ask the witness again?

MR. SCOTT:

Q Well what about it, Mr. Claridge, I'm directed to ask you again.

A Those are all of the safeguards that we would definitely recommend at this time, yes.

Q Aren't those safeguards that would be performed by any sensible man?

A No, a good number of these safeguards would not have been applied on construction in

other pipelines in non permafrost terrain and we're into a new type of construction and I think it's fair to say these are special precautions that are tailored to the terrain that is going to be crossed.

Q And just so I have it clear, that's all of them?

And that's what you intended by that sentence?

A Yes sir.

Q Now let me just ask one short question or two short questions about community laterals, and particularly, the Pine Point Yellowknife lateral. Now as I understand it, Mr. Mirosh, in an earlier panel has indicated that -- and perhaps he confirmed this morning that the operating temperature of this lateral will approximate ground temperature after a certain point. Do I have that correctly, Mr. Mirosh?

WITNESS MIROSH:

A Yes sir.

Q Yes. Have the geo-technicians on the panel looked at the lateral in geo-technical terms yet?

WITNESS CLARIDGE:

A Mr. Dan Wasylk of Klohn Leonoff during the last week has been in fact examining the conditions along the lateral and I believe Mr. Wally Drew is in the hotel today, in fact, to do the same thing and we will I'm sure be made aware of their findings.

Q I presume he was only in the hotel for lunch. He should be out there in the --

I take it there is nothing on it yet for us?

A They're not fast enough for that, no.

Q Now as geotechnicians, do you anticipate any special design requirements because of the nature of the lateral, that is, portions of it are hardrock, interspersed with muskeg and frozen silt. Do you see any geotechnicians work inherent in that kind of terrain?

WITNESS DAVISON:

A A concern that we could have, it is a small pipeline, small diameter, small weight, but a concern that we would have would be settlements, differential settlements due to irregularities.

Q Is it too early to say how you're going to deal with that?

A Yes, at this time.

Q I take it that you haven't looked at this line in the Fort Providence area? Or you at least haven't any information on what problems may exist there?

A This information that has been gathered is of such a fresh, new time that I'm not acquainted whether we have looked at that particularly. It's going to be done, I would say, within the next week, if it has not already been done. I would say within the next week if it is not already being done.

MR. SCOTT: Thank you very much,

gentlemen, those are all the questions.

THE COMMISSIONER: Any re-examination?

MR. HOLLINGWORTH: Yes, Mr. Commissioner, a couple of questions.

RE-DIRECT EXAMINATION BY MR. HOLLINGWORTH.

Q Dr. Yip, during your cross-examination by Mr. Marshall, a question was put to you as to any studies of a geotechnical nature which might have been done on the so-called cross delta route, across the Mackenzie Delta, and you undertook to check and see if you had any studies. I wonder if you could answer that question at this time?

WITNESS YIP:

A In response to Mr. Marshall's question in regard to Mackenzie Delta crossing. the statements that have been read, no report has been done regarding geotechnical data because I was-- didn't comprehend his question, last night.

Q Mr. Claridge, yesterday there was some discussion between you and Mr. Marshall about the co-efficient of consolidation. and I wanted to know if you are aware of any field data which Canadian Arctic Gas has which might tend to support or discredit this theory?

WITNESS CLARIDGE:

A Yes sir, I'm aware of some data that was referred to in a publication. This publication was in turn referred to in a report by Northern

Engineering Services in response to a question from the National Inergy Board, it could refer to that. It has a title, "Some Aspects of Natural Slope Stability in Permafrost" in relation to the applicant's proposed pipeline this was prepared in October, 1974 and it must be an exhibit, I would imagine. The paper referred to in that publication as support is by Dr. McRoberts, Dr. Morgenstern, who I believe are also consultants to Northern Engineering Services.

Now in this paper, there's a reference, I might quote the paper, it is the Canadian Geotechnical Journal, Volume XI. Number 4, November 1974 and this same paper was raised as item 31 in Section 3B-2.1 of the Foothills application and I believe I was asked if I had read it yesterday. In the meantime I have reviewed it,.

Now in this paper by McRoberts ad Morgenstern, reference is made on pages 461 and 462 to a case record known as Fort Norman Landslide, where it is claimed that field measurements of pore pressure were made which confirm the theory referred to. Now this is the co-efficient of consolidation that is used in the so-called consolidation theory. To my knowledge and I'm sure I'll be corrected if I'm wrong, there is no additional field data on slopes which substantiate this theory, thus we must attach great importance to the measurements of pore pressure in this landslide.

Let me just briefly describe how the pressure data were obtained. The authors report

that the test measurements and I quote "were made by inserting a self sealing tapered piezometer through the active layer until it came to rest on the thawing interface". Free water is mentioned as being ponded at the ground surface at the location of all but one of the piezometers thus it must be assumed that the soil is saturated. Pore pressures were measured to be well above the level associated with hydrostatic conditions and the authors indicate that the result predicted by the theory was reasonably satisfactory although in fact the actual measurements were even higher than predicated. I mentioned last night that this theory can predict high values of co-efficient of consolidation.

I questioned how the field data were determined. I note that one of two types of piezometers used involved a Geonor tip. We have also been using Geonor piezometers in our work for Foothills' Pipe Lines and we understand them. They have a diameter of approximately one inch.

During insertion of the piezometer, a volume of soil corresponding to the depth of the probe at a diameter of one inch is displaced. The effect of this displacement is to remould the soil into a slurry, or it may, if one were to measure the pore pressure corresponding to a column of slurry, pore pressure ratio which, I believe, is referred to as an RU value in the range of from slightly more than one, or slightly less that one would be obtained, depending on the assumption made of soil density.

The measurements of pore pressure ratio in fact were calculated to be between 0.88, and 1.09. It is interesting to note that on a graph of measured pore pressure versus time from installation, that the pressure levels are changing. This is to be expected as the soil reacts to the severe disturbance associated with inserting the probe. The time allowed until completion of testing varied between about 10 and 120 minutes, with a median of 40 minutes. This time, in my view, is an entirely insufficient period to permit the dissipation of pore pressure created by insertion of the probe, indeed even to fully activate the piezometer in the case of the Geonor

design.

Thus, an equally plausible interpretation of the results obtained is that they served simply to measure the density of the remotest soil slurry. The mistaken conclusion is then reached that high access pore pressures exist which may not be the case. Our concern regarding the possible over-estimation of pore pressure, when using the CV parameter and the thaw consolidation theory applied to slope stability is therefore reinforced by this dubious testing. The implication arises, as I stated yesterday, that the resistance of slopes to failure may accordingly be seriously underestimated with grave environmental consequences.

MR. HOLLINGWORTH: Thank you. I have no further questions, Mr. Commissioner.

THE COMMISSIONER: Well then, this panel may be excused, and thank you gentlemen, for coming and sharing your knowledge and experience with us.

Thank you very much.

(WITNESSES ASIDE)

THE COMMISSIONER: Before we adjourn for coffee, a couple of matters of no great consequence. A week from Monday, two weeks from Monday, the Inquiry will be holding community hearings in the South Slave area in Fort Smith, Pine Point and Fort Resolution. Two matters that arise are these.

One is, Mr. Genest and Mr. Marshall, at the Fort Simpson hearing, Mr. Workman, who is giving evidence in the usual way outlining the project for Arctic Gas, said that in the peak construction winter there would be 4,000 men north of 60. At the time I thought that figure was wrong and I said to him, isn't the figure larger than that? He said "No", so it was left there, but just because we have the construction panel coming up this afternoon, I had my notes out on the construction evidence we heard from Arctic Gas, and you might refer this to Mr. Workman just so that if he's wrong, he will know and if I'm wrong, we will know that too.

Mr. Williams at page 5575 and following, said that in the second construction season there would be nine spreads, six of them north of 60, and three south of 60. This may be my own conclusion in my notes, but I have written down here, so there would be about 6,000 workers north of 60 in the peak winter construction season. I just don't want 2,000 workers to be lost in the discussion of the project. Just ask Mr. Workman about that.

The other matter that I wanted to raise relates to Foothills. Mr. Hollingworth, I suppose Mr. Ellwood is coming as usual. This will be a community hearing in a place whose principal connection with the pipeline in a physical sense, is your feeder lines or branch lines or whatever you call them, and so you might make sure that Mr. Ellwood discusses the, certainly in Pine Point and Fort Smith, the

advantages that will accrue to the community, in the view of Foothills, through the delivery of this gas and so forth, and -- excuse me?

MR. HOLLINGWORTH: I'm sorry, sir, Fort Smith is not---

THE COMMISSIONER: I'm sorry, of course it isn't. I mean Pine Point, forgive me. Well at any rate, at Pine Point you can dilate on the advantages to your heart's content, but you might also make sure Mr. Ellwood discusses the construction program in relation to the bringing of gas to Pine Point, and he might also be prepared to indicate in Fort Smith and Fort Resolution the reasons why they will not be getting in on this.

Well that's not terribly important, but I thought I would mention it. Well, we will adjourn for a few minutes for coffee and then you can present the construction panel.

MR. HOLLINGWORTH: Certainly, sir.

(PROCEEDINGS ADJOURNED)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. HOLLINGWORTH: Mr. Commissioner, we're now ready to commence on the tenth panel of Phase I evidence, Foothills Pipe Lines the Construction Plan. The panel, some of whom are known to you, on my immediate, or my far left is Mr. Paul Jarvis, consultant for Foothills and Mr. A.F. Bauer next to him, who has been on a previous panel. Mr. Mirosh who by now is familiar to us all and on my far right is Mr. Walter Kosten, also a consultant to Foothills Pipe Lines.

Has the panel been sworn, Miss Hutchinson.

EDWARD A. MIROSH: Recalled

A.F. BAUER: Recalled

WALTER KOSTEN: Sworn

PAUL JARVIS: Sworn

DIRECT EXAMINATION BY MR. HOLLINGWORTH:

Q Mr. Mirosh, proceeding directly to question 3, if we might, can you highlight some differences between the CAGPL approach and the Foothills approach towards construction planning?

WITNESS MIROSH:

A There are several differences which I would like to highlight. To highlight the differences it is necessary to compare mainline construction in the Northwest Territories between the two projects. The most significant difference in construction activities is that CAGPL have estimated that

they can construct an average of 75 miles per mainline spread whereas Foothills have determined that a mainline spread would construct an average of 55 miles. This difference is all the more significant in that the spreads for Foothills would be working with 42 inch pipe of a wall thickness and grade which is close to previous contractor experience.

THE COMMISSIONER: Excuse me, Mr. Mirosh. Forgive me, an average of 75 miles per mainline spread per winter?

A Yes sir.

Q And yours is 55 miles per winter per spread?

A Correct.

Q Carry on, sorry.

A This difference is all the more significant in that the spreads for Foothills would be working with 42 inch pipe of a wall thickness and grade which is close to previous contractor experience, whereas CAGPL spreads would be working with a 48 inch pipe with a thicker wall and with crack arrestors for which no applicable construction experience is available. Foothills feels that 55 miles average per construction spread is a realistic spread productivity especially considering the harsh environement, the unknown factors of construction in the north, and the degree to which pipeline crews will not have a full contingent of seasoned personnel available. It is tempting to estimate a higher productivity rate per spread in that a higher productivity would significantly reduce fuel consumption, equipment

requirements, manpower, camp and total construction spreads and would subsequently go a long way towards reducing total capital cost for the project. CAGPL have estimated that they will require a maximum of six construction spreads whereas Foothills for similar mainline construction estimate a maximum requirement of eight construction spreads.

Since both projects would require the same contractors working with the same labour pool and the same equipment to undertake either job, then Foothills consider that CAGPL have overestimated the productivity that is attainable under the circumstances. In fact rather than the CAGPL project showing a better productivity rate it may well show a lesser productivity rate in view of the large diameter, thicker wall pipe and crack arrestors involved in that project.

THE COMMISSIONER: Excuse me again, Mr. Mirosh. Am I to take it from what you say that Foothills feels that Arctic Gas will not construct 75 miles per mainline spread per winter, that your view is that they may well not reach Foothills estimate of 55 miles per mainline spread per winter?

A Yes that's the implication of that statement sir.

THE COMMISSIONER: All right.

A A second major difference between projects occurs in the tonnage of pipe, fuel and other materials and equipment which we consider is required for mainline construction activities in the Northwest Territories.

THE COMMISSIONER: Excuse me. Forgive me for interrupting again, but does that -- if it turned out that you were right, then would that mean that the Arctic Gas Project would not be completed in the three winter seasons of pipeline but might take four or even five years.

A Yes, or if they could find more spreads, I suppose they could increase the number.

THE COMMISSIONER: Mr. Scott, this question of construction schedules and -- is an important one because we have heard from the Chamber of Commerce of the Northwest Territories that they wish to advance a proposed construction program which the pipeline companies would be required to abide by which would stretch out the period of construction beyond the contemplated peak, three winters. Magistrate Sprecker who gave evidence in Whitehorse, he was from Alaska, he wasn't speaking about construction schedules, but he said that Alyeska was already a year behind. When you are considering evidence to be brought from Alaska, would you see if you can find some witness to come here to tell us what their original plan was in terms of construction, how long they thought their construction program would take, how long it is taking and how long it looks as if it is going to take. Well, carry on.

MR. HOLLINGWORTH: Mr. Mirosh.

A A second major difference between projects occurs in the tonnage of pipe, fuel and

and other materials and equipment which we consider is required for mainline construction activities in the Northwest Territories. Foothills have estimated their total tonnage required in the Territories to be slightly in excess of one million tons. By examining the CAGPL application, we have extrapolated their tonnage requirements for mainline activities in the Northwest Territories to be somewhat in excess of 1.3 million tons. Of this tonnage, Foothills would require 539,000 tons of pipe whereas CAGPL would require 810,000 tons of pipe. The logistics for pipe between the two projects will be more difficult for CAGPL in that their tonnage is greater. In addition, since their pipe diameter is larger and their joints are heavier, they are likely to be more restricted in handling and shipping pipe, especially on rail cars and barges.

For fuel, Foothills has estimated a total fuel requirement of 284,000 tons which includes our estimated propane and aviation fuel needs. Based on the CAGPL estimate, we have extrapolated their requirement at 173,000 tons, which figure does not include propane. One of the presumed reasons for the fuel discrepancy is the productivity rate which CAGPL have assumed. If the productivity rates are the same, or if in fact, those for CAGPL are slightly less than those for Foothills, then the fuel requirement would presumably be considerably higher for CAGPL than for Foothills. It is significant to bear in mind that such large differences in fuel create large differences in transportation requirements for shipping this fuel and for storage.

A third difference between projects has been mentioned before and is that CAGPL are planning eight permanent airstrips for operation and construction whereas Foothills will rely upon helicopter transport supplemented by fixed-wing aircraft operations during construction from winter airstrips and lakes along the construction zones.

Both CAGPL and Foothills assume that extensive use will be made of the Mackenzie River for barging construction materials. CAGPL have estimated that they will require the addition of a fleet of 11 barge and tug sets in order to move their tonnage of material and equipment in the Northwest Territories. Again, because their spread productivity figures are higher than that of Foothills and since their subsequent fuel consumption is lower than that of Foothills, there is an implied savings in the number of barges and tugs required to move CAGPL tonnage. On the other hands, Foothills calculates that an additional eight new barge and tug sets will be required to move its tonnage in the Northwest Territories.

Q Can you briefly outline your plans for staging materials at Hay River, Enterprise and at other locations along the Mackenzie River?

A Existing rail trackage from southern Canada passes through Enterprise and terminates at Hay River. We plan an intermediate staging area at Enterprise with supplementary staging and storage at HayRiver. Enterprise would be used primarily for off loading material which would move to staging areas other

than Hay River or which would move by truck and permanent highway or winter roads to stockpile sites along the Mackenzie Valley.'

Hay River would be used to the maximum extent possible for movement of material directly from rail to barge with a modest amount of storage. To supplement these two areas, we are currently anticipating that we will develop a major staging area at Axe Point which is located directly across from Mills Lake. Axe Point would give us the advantage of being downstream of the Fort Providence rapids on the Mackenzie River and in addition would give us a two week earlier start on the barging season due to earlier ice breakup compared to the Great Slave Lake. The site which we would propose to use at Axe Point is a former RCAF base and this location naturally lends itself to good storage and in addition appears to have excellent bank conditions for barging operations. Axe Point would be accessible by an all-weather road from the Mackenzie Highway and the construction of such a road has been included in our latest plans.

There are other locations which we are considering as secondary staging areas and these are Dory Point, Poplar Landing, Fort Simpson and the Mackenzie Highway Crossing of the Mackenzie River north of Fort Simpson. We have not completely assessed our needs for transfer and staging areas other than Hay River, Enterprise and Axe Point at this time, however, our studies are continuing in this area.

Q You had previously mentioned

your barging requirements and the fact that you estimated a need for eight barge sets. Could you elaborate on this?

We plan to ship material by barge from both Hay River and Axe Point and possibly from other locations as indicated earlier. Such material movement would originate at these locations and would terminate at various wharf sites along the Mackenzie River. We have determined that we would have a shipping season of about 105 days in duration out of Axe Point, and that the shipping season out of Hay River would be about 88 days.

In calculating the number of barges and tugs which we require, we have taken the worst case shipping season, that is assuming only 88 days of shipping season available out of Hay River.

Based on shipping out of Hay River, we have estimated our average cycle time for delivering materials into the Mackenzie Valley to be 8.6 days, with an additional two and a half days for loading and offloading, giving a total average cycle time for each barge return trip of 11.1 days.

Although in our application we assumed that we would use 2,000 ton barges fully loaded, we have in our latest calculations assumed 1,500 ton barges loaded to an average of 1,150 tons.

Based on the above parameters, we have determined our maximum barge and tug requirements to be about 8 barge sets. A barge set would be made up of six 1,500 ton barges and one 4,500 horsepower tug.

As previously mentioned, CAGPL have estimated their requirements at eleven barge sets

and on the assumption that three such complete sets would be available from existing operators, they have indicated in their application that their total requirements would be eight such sets. We are not certain if this assumption can be made, however, if we also can assume three barge sets being available from the existing operators, then our requirement would drop from eight to five such barge sets.

To relieve pressure on Hay River and Axe Point, we have been investigating the supply of fuel into the Mackenzie River system by tanker in the Beaufort Sea. We feel that this may be feasible and are currently investigating this further. If we were able to do so, then although we would not realize a significant barge and tug saving, we would, however, be able to greatly relieve transportation pressure on the southern part of the Mackenzie Highway and on the southern part of the Mackenzie River system.

Q Aside from barging, do you see any other means of transportation along the Mackenzie Valley?

A Yes, we are contemplating the use of an existing winter road which stretches from Fort Simpson to Inuvik. We feel that some material, particularly material required in an early stage of the project, could be shipped by means of this route. We would also utilize the Mackenzie Highway to its fullest extent.

Q Can you describe your approach to the development of wharf sites on the

Mackenzie River?

A Our current estimates are based on upgrading all existing wharf sites if such upgrading is acceptable to the communities in which they are located. At other points, we have located wharves which would be near to good storage areas and in proximity to construction camps along the pipeline route. At these locations we anticipate the installation of temporary wharves which could be composed of floating structures and which would be removed during the winter time to prevent damage by ice. Using this approach, we would not plan on leaving a wharf structure on the Mackenzie River after construction is completed.

Q Mr. Bauer, you're supervisor of construction and planning for Foothills Pipe Lines Limited?

WITNESS BAUER:

A Yes.

Q In that capacity, have you appeared before this inquiry previously?

A Yes, I have appeared as a member of the pipeline design panel.

Q Please explain what you mean by conventional buried pipeline construction, esepcially with respect to permafrost and other sensitive terrain.

A It is anticipated that essentially conventional established winter pipeline construction techniques will be employed on this project. These techniques have been developed over

approximately the last ten year period, permitting a more economic installation of pipelines in those areas in which muskeg was prevalent. Winter construction over sensitive permafrost terrain is considered to be similar to winter construction over muskeg.

Winter pipelining today is a standard procedure, in terrain where it is applicable. To this extent the various operations are described:

(a) Clearing. No particular aspects are unique. Clearing in winter provides more stable ground, and in areas of poor merchantable quality timber, permits machine clearing as compared to hand clearing. Such areas would generally be muskeg and in the case of this project would also include sensitive permafrost soils.

(b) Grading. Operations are carried out by bulldozers. In winter operations in muskeg the frost is driven in by repeated passes of the equipment on the working side. It may be necessary to use light muskeg-type vehicles on the working area and ditch line to drive the frost into a sufficient depth to enable the ground to support the ditching equipment. In areas that are not muskeg, a mound is formed over the ditch line to prevent frost penetration. This mound is removed immediately ahead of the ditching operation. For this project the same operations will apply to sensitive permafrost terrain as to muskeg. In addition, snow roads will be used to protect sensitive permafrost tundra from vehicular traffic where possible.

(c) Stringing. This is

carried out by off-right-of-way stringing trucks. Frozen ground facilitates truck movement in muskeg terrain. For this project, we would use snow roads on sensitive permafrost terrain to protect the tundra where possible.

(d) Bending. Bending usually requires pre-heating of the pipe at the point of bending, dependent on the ambient temperature during the day. The bending of the pipe conforms to the line of the grade, rather than to the bottom of the ditch. The sequence of operations for winter construction is changed, as in summer pipeline construction ditching precedes the bending operation.

(e) Line-up. The pipe is joined in this operation and the first weld pass is applied. Pre-heating of the pipe ends are a normal practice in winter pipelining. Also, the weld is covered with an asbestos blanket wrap to control the cooling rate.

(f) Welding. The filler and cap passes are applied to the weld during this operation. Again, pre-heating and applying a weld wrap are standard procedures to control the cooling rates.

(g) Ditching. In winter pipelining practice, the ditching operation follows the welding operation and precedes the coating and lowering operation. This sequence is adopted to minimize the time between opening of the trench, lowering and backfill. Ideally, the ditch is excavated, the pipe lowered into the ditch and the ditch backfilled at any given location within the span of one day. This

procedure is followed as close as possible. This procedure keeps the ditch spoil from consolidation due to freezing, and where it can be accomplished eliminates the need for padding placement if the soil type is suitable and does not contain excessive boulders.

As mentioned earlier, the frost penetration along the ditch line is controlled by placement of a cover mound during the grading. The removal of this mound is performed immediately ahead of the excavators, usually during the same day.

(h) Coating and lowering. It is general practice to utilize a tape or extruded plastic-type coating on winter construction. When the line is tape coated the pipe is heated and dried by the use of line heaters preceding the cleaning and coating of the pipe. The pipe is normally lowered directly into the ditch where possible, from the coating machine.

Dependent on the terrain, the pipe can be coated ahead of the ditch, lowered back on skids, and then lowered into the ditch by a separate lowering operation.

If the pipe is supplied precoated, this operation then consists of patching the welds, and any other areas where the coating may have suffered damage.

(i) Tie-in. This is a standard operation and other than pre-heating of the welds, there are no unique features in winter pipelining.

(j) Backfill and clean-up.

The backfill operation follows immediately behind the lowering of the pipe and areas other than locations of a tie-in weld are backfilled with the clean-up roughed-in. If the ground has become frozen for some reason, padding of the pipe with fines is necessary to prevent damage to the pipe and coating. This is normally required as well at tie-in locations. If the soil contains excessive boulders, bedding may be necessary ahead of the lowering operation, as well as padding after lowering.

(k) Clean-up. This crew completes the clean-up and the dressing-up of the right-of-way. Normally a mound of material is left along the ditch line to compensate for settlement of the ditch backfill material when it thaws. This mound is larger than that provided on a summer project, as the backfill material will have greater voids on a winter project. Revegetation is deferred until the summer months and generally aerial seeding is performed by helicopter.

As can be expected, efficiency of the crews is somewhat decreased on a winter construction project. The provision of portable heated shelters for the various crews is common practice now. The manpower is normally higher, as spell-off personnel is provided to prevent over-exposure to the cold.

Equipment maintenance is higher due to greater equipment breakage in cold weather. Further, it has been recognized that effectiveness of the personnel is excessively reduced and the contracts

will provide a minimum temperature below which certain of the operations will not be carried out.

Q Can you explain why you propose to clear the route one year in advance of actual construction?

A The general approach to the right-of-way preparation has been to effect maximum use of the equipment, spread out the work to reduce peak manpower requirements, provide an opportunity for the integration of northern native personnel at an early date and pre-construct to the extent that it is reasonably practical, for those operations ahead of the actual pipeline construction so as to minimize congestion on the right-of-way and provide early access in the area where permanent roads do not exist.

Further, in those areas where a large volume of granular material may be required, this material would be prepared and placed ahead of the pipelaying operations with the foregoing considerations in mind.

To this extent, the clearing and grading operations will be more labour intensive, with some hand clearing anticipated in such areas where merchantable timber exists. It has been proposed, therefore, that these operations would precede the pipe laying operations by one winter construction season.

Inasmuch as the routing of the line is not considered finalized, at this time, and may be subject to changes in certain areas, during on-going

investigations, it is premature to predict the volume of materials required to be moved at specific locations.

In areas where the terrain is relatively level, the clearing operation can be performed with no grading to provide access along the right-of-way to establish a working base for the construction activities. The similar principle applies where the terrain is rolling, and where the right-of-way does not encounter extensive side slope, although where steep grades are encountered along the right-of-way, such as at ravines, river and creek crossings, side trails may be required to facilitate wheeled vehicular traffic around areas of steep grades.

Where extensive side slopes are encountered along the right of way. in order to facilitate safe operations. right of way preparation is required to provide a level working surface. This is accomplished by cutting and filling, with the necessary preventative measures to aboid deterioration of the slopes. In such areas, in some instances, it is anticipated that importing of granular material may be necessary where sufficient material is not available within the immediate area, and to prevent deep cuts in the side slopes. In such areas necessitating cutting into side slopes, measures will be taken to prevent slope and right of way deterioration, particularly in permafrost areas and in such areas, grading would be deferred to the pipeline construction season with side trails constructed to allow access around such areas during the clearing operation.

In those localized areas. requiring extensive fill material, it would be the intent to haul and place this material after clearing.

MR. HOLLINGWORTH: Mr. Commissioner I have a question for Mr. Bauer which is not in the printed evidence. I don't think it will be very contentious but during the design panel, a question of concrete weights came up and as I anticipated, some of my friend might wish to cross-examine on that, I thought I'd ask Mr. Bauer to make a statement correcting what he said previously about these.

A Yes Mr Marshall directed a question at me and as far as the estimate of percentage

of concrete rates and I replied with a 50 percent figure. Now the 50 percent of the total line does not mean 50 percent of the concrete weights. It would be 50 percent of the 50 percent as far as concrete weights are concerned.

THE COMMISSIONER: You're not making yourself very clear to me, I don't know about anyone else. Can you rephrase that answer?

A The total estimated figure so far is 50 percent of the total line to be back, to be weighted, overcome to achieve negative buoyancy.

Q Yes.

A Now 50 percent of that total figure would be approximately concrete weights the remaining portion would be select back-fill and so on.

Q So you're saying that you are going to require negative buoyancy techniques on 50 percent of the route and that one half of this 50 percent or 25 percent of the total would involve concrete weights?

A That's right, that is correct.

MR.GENEST: And the other 25 would be back-fill?

MR.HOLLINGWORTH: Yes, that is my understanding. I might say too, Mr. Commissioner, once again the mag card machine that puts out these summaries seems to have defaulted on numbering pages in some instances so that while we have -- at least this copy has numbered pages 1 and 2, they are then not numbered until page 14 and in fact, I started putting in my numbers by hand and I got

to page 12, I turned the page and I got to page 14 so there's no page 13.

THE COMMISSIONER: That's good.

MR. HOLLINGWORTH: We'll have a lucky panel.

MR. GENEST: That takes out a whole lot of cross-examination.

MR. HOLLINGWORTH:

Q We can proceed with Mr. Kosten's evidence. Mr. Kosten, you're the president of Energy Systems Engineering Limited, a consultant for Foothills Pipe Lines?

WITNESS KOSTEN:

A Yes.

Q Does the sheet attached to the prepared evidence and having your name at the top accurately describe your academic qualifications and experience?

A Yes.

Q Can you read that into the record please?

A Education: Bachelor of Science in Engineering, University of Saskatchewan, 1951.

Bachelor of Law, University of Saskatchewan, 1956.

Banff School of Advanced Management Diploma, 1967.

During the summer of 1955 and

1956, Pipeline Inspector and route locator, Fish Engineering Limited.

1957 - Joined Mannix Co. Ltd. as Division Engineer of the Pipeline Construction Division In this position until 1962 when assigned as Project Manag of a pipeline construction project. Appointed Construction Supervisor of the Division in 1963 and Division Manager in 1964. During the period of 1963 to 1968 approximately 1200 miles of pipeline were constructed by the Division.

In 1969 appointed Special Projects Manager responsible for/the examination of New Ventures.

In 1970 transferred to Techman Ltd. and appointed General Manager of a Pipeline Engineering Consortium responsible for the recruiting of professional engineering personnel and developing the consortium into an engineering consulting organization

In 1974, resigned to establish a new engineering consulting firm and presently president of this firm.

Affiliations Societies. Association of Professional Engineers, Geologists and Geophysists of Alberta; member of the Engineering Institute of Canada; and Past Director of the Pipeline Contractors Association of Canada, 1964 and 1969 and Past President, 1967- 68 term.

Q Would you please give a description of the construction of the mainline portion of the project in summary form?

A The mainline pipeline is proposed to be constructed with eight pipeline construction spreads. It is proposed to construct seven of the eight spreads over two construction seasons, the eighth spread being constructed during the first pipeline construction season.

It is proposed that right-of-way preparation will be carried out one season ahead of actual pipeline construction. Thus, the construction activities will be carried out over three construction seasons. It is anticipated that possibly some restoration measures may be required in the fourth season as well.

Q What construction resources are available or are anticipated to be available to enable the successful completion of the project?

A The Pipeline Constractors Association of Canada lists 42 regular members which represent themselves as pipeline construction contractors or service contractors. While there are other contractors that are not members of the Association the membership includes most of the contractors that would be considered to have the capabilities of fielding one or more spreads for a project of the nature that Foothills proposes.

It is submitted that a good example of the capabilities of the Canadian Pipeline Construction Industry is the recent award by Interprovincial Pipeline Company for the construction of the Sarnia to Montreal project. This project has been

organized to be constructed with seven spreads, over 520 miles to be constructed during one season. The work was awarded to five pipeline contractors.

While that project consists of 30 inch pipeline, as compared to Foothills 42 inch pipeline, the I.P.L. project contains a substantial amount of rock work. We have recognized that upgrading of some of the construction equipment will be required to enable them to handle 42 inch diameter pipe; this has been taken into account, and subsidization, if required, is anticipated by Foothills to accomplish this upgrading for this project.

It is also anticipated that some of the pipeline contractors will enter into joint ventures with non-pipeline contractors to bolster their financial and personnel resources for the Foothills project.

Foothills are cognizant that there proposed project will require substantial pre-project planning, organization and financial commitments, relative to a similar magnitude of a project in Southern Canada, and these factors have been taken into consideration in the development of Foothills' concept.

Q Can you explain the time sequence for construction and how it was arrived at?

A The time sequence for construction was developed from an assessment of the terrain, the conditions under which the construction spreads would be required to work, and the present anticipated construction resources existent in Canada.

Also taken into consideration was the fact that a substantial number of spreads would be required which would tax the resources of the contractors in terms of equipment and personnel.

It was recognized that on a project which consisted of a single spread, the constractor could be selective as to the personnel, to the extent that the most competent tradesmen could be selected, resulting in maximum production. On a project of this nature, requiring numerous spreads, it will be necessary to have the most competent personnel distributed over all the spreads and augment the balance of the requirements with newly trained or in some instances, untrained personnel and have them acquire the experience during the course of the job.

Experience has shown that under such circumstances, decrease in production will result, at least at the start of the project, thus resulting in a draw-down of the overall average production that can be anticipated.

This factor, coupled with the winter conditions that are anticipated in the area, lead to the conclusion that the volume of work that could be reasonably accomplished in one season would be of the order of 50 miles in the northern end, to the order of 75 miles in the southern end, per season, the average being about 55 miles.

It was also concluded that because of the resources required, as well as the support facilities, it was not practical to consider the work being done in one construction season.

As a result, it was concluded that the project could be completed by the utilization of seven and eight spreads over two winter construction seasons, for the actual pipeline construction.

Consideration has been given to possibly conducting the most southerly spread one season ahead of the remainder, that is during the same season that the clearing and grading is proposed to be carried out. This would reduce the total spread requirements for the project down to seven.

Inasmuch as the right-of-way preparation may involve a requirement for the movement of a considerable volume of borrowed material onto the right-of-way, it was concluded that it would be desirable to perform this operation, as well as the necessary clearing prior to the commencement of pipeline construction. It has therefore been proposed that these operations be performed one season prior to the start of the actual pipeline construction.

This procedure would reduce the peak equipment and manpower requirements, extend the construction period for the labour forces, assist the northern labour to familiarize itself with the equipment, and in those areas beyond present road access, afford some access for the installation of the support facilities that would be required for the main

construction spreads, such as camps, warehousing and storage facilities.

Q Do you feel that sufficient skilled and unskilled labour will be available for the project, and do you plan to utilize northern labour?

A The availability of skilled labour for any project is a function, to a degree, of the market and of the incentives provided to attract labour. In order to attract craftsmen to a project in a remote area and work under conditions that are anticipated, the appropriate incentives must be provided, and these have been duly considered in developing Foothills' project.

It is submitted that the nucleus of the crews of tradesmen that will be required are presently available, and we refer again to the example of the Sarnia to Montreal pipeline, wherein seven spreads will be utilized. The craftsmen involved in pipeline construction are welders, machine operators, Teamsters, and skilled and unskilled labourers.

To the extent that work is available for the skilled tradesmen, historically there have been sufficient available to fill the needs.

The contractors, through the Pipeline Contractors Association of Canada, and in conjunction with the trade unions, have made it a policy over the past ten or more years, to provide and arrange training programs for the skilled trades, to enable prospective trainees to acquire the basic skills required for the opportunity to work on a project.

Due to the relative decrease in pipeline construction activity in the last year or two, prospective trainees experienced little opportunity to utilize their training due to lack of work opportunities, and so interest in the training programs decreased to the extent that the last two welding training programs, one in 1974, and one in the spring of 1975 had to be cancelled.

The Association is quite willing and anxious to promote the training of prospective tradesmen, and a project such as Foothills proposes will provide an excellent incentive for the promotion of such programs. This avenue has been explored with the Association and plans are being developed to pursue this avenue.

These programs will also provide the opportunity to train northern natives for those that are interested in these opportunities.

Aside from such training programs, however, the skills required on a production basis on a pipeline project must be acquired on the job; that is a training program will teach the basic skill, for instance of a welder, but as with any other trade, it is through the application of that skill through practice that the individual can achieve the productivity that is acceptable on an actual project.

To this extent, for a project of the nature proposed it has been anticipated that productivity on each spread will be low, at least at the start of the project, due to a certain contingent

of limited personnel with limited experience. To this extent, it has been anticipated that a nucleus of various experienced, skilled personnel will be available, who will be augmented with personnel who will have limited experience, and will acquire this experience as the job progresses.

It is also conceded that at the start and throughout the project, there will be the normal contingent of personnel that find that the job or the conditions are beyond their capabilities, causing a turnover of all labour. Of labour rather. All of these factors have been considered.

With respect to the use of northern labour, the contractors and the Association have shown a cooperative attitude in attempting to give those interested an opportunity for on the job training, and an attempt is being made to provide this opportunity on the Sarnia to Montreal project.

Inasmuch as the northern natives who have had little exposure to pipeline construction in the past, they will, to a large extent, be limited to the type of work they can perform; operations such as clearing and grading can utilize a larger quantity of unskilled labour. This was considered in Foothills' proposal to perform this activity one year ahead of pipeline construction, thus providing employment opportunities over a longer period for such of the northern labour that had an interest. To the extent that is practical, Foothills will stipulate conditions requiring the use of northern labour on the project. This will

require coordinative efforts with the native people, and it is Foothills' intent, as a matter of policy to pursue this course.

Q Mr. Bauer has mentioned ditching. Can you elaborate your approach to ditching for pipeline construction?

A The aspect of ditching as it relates to the Foothills project involves a consideration of the techniques that will be employed in ditching under essentially conventional conditions which do not present unusual problems, and ditching in permafrost, in which little experience has been acquired on a large production basis as related to pipeline construction.

Our assessment of the project is that approximately one-half of the project, namely the southern half, conventional ditching techniques will be employed, and special techniques will be required in those areas that are classified as discontinuous permafrost.

In soil that is not in a state of permafrost, ditching is carried out by covering the ditch line with a berm of material from the right-of-way to prevent deep frost penetration. This material is removed immediately ahead of the ditchers, and can be ditched with a wheel trencher with no unusual problems in areas that are not boulder infested. The latter require excavation by backhoes.

In those areas that are in a state of permafrost, it is anticipated that dependent

on the soil characteristics, some types of soils will be able to be ditched with a wheel trencher in the normal manner, with presently developed eouipment. There has been research carried out in an attempt to develop ditcher components for ditching in permafrost with some degree of success.

Foothills considers that in order to achieve an acceptable production rate with either a trencher, a ditcher or a backhoe, a modified blasting technique will be required to be carried out ahead of the excavating equipment, where a state of permafrost is encountered.

Such drilling and blasting techniques would utilize an explosive charge per unit, to break the material up to the extent that it would be readily workable with either a trencher or a backhoe.

While such a technique has been carried out in tests to date, Foothills intend to carry out further tests in this area prior to the actual pipeline construction.

Q Mr. Jarvis, are you vice-president and General Manager of Unies Limited, consulting engineers of Winnipeg and Edmonton?

WITNESS JARVIS:

A Yes.

Q Do the sheets attached to the prepared evidence and having your name at the top, accurately describe your academic qualifications and experience, relevent to construction of winter roads and your general construction experience?

A Yes.

Q Would you read the contents of the sheet, please?

A My education is a Bachelor of APplied Science from the University of British Columbia in 1958. I am a registered civil engineer in the Provinces of Manitoba and British Columbia, and a registered forest engineer in the Province of Ontario.

My experience in 1957 to 1959, employed with the Abitibi Paper Company Limited, the Lakehead Woodlands Division, as a logging superintendent and assistant construction engineer, where I was responsible for the construction of forest access roads, layout and location of main and branch roads, TB-A1 concession Abitibi Paper Company; winter gravel haul for the construction of all-weather roads; the construction and maintenance of winter roads and the design and construction of the Spruce River Road.

In 1960 -- '59 and '60, I was employed with Sir Alexander Gibb and Partners as site engineer, the Lakehead Harbour Terminal. As part of my duties I was responsible for the drilling and pile testing operations being carried out on harbour ice, and the construction and maintenance of the ice sites and access. The contractor was Thunder Bay Harbour Improvements Limited.

In 1961, '60 and '61, I was employed as logging superintendent and woods manager of Mathieu Lumber Company Limited, Sapawe, Ontario. I was totally responsible for the location, construction

and maintenance of a 25 mile main winter road, 15 miles of which were constructed over ice, and approximately 30 miles of branch road provided for hauling some 100,000 tons of pulpwood and saw logs by company forces and trucking contractors.

1964-65, Gibb, Underwood McLellan, Winnipeg, Project Engineer, Churchill Diversion and Borntwood Power Sites.

I was engaged in site investigations, drilling operations, camp constructions on hydro power projects; supervision of cat swing contract, Mid-West Drilling were the constractors; winter truck haul road analysis and location study from Thompson Manitoba to Missi Falls in concert with Sigfudson Transportation, Lyndal Transportation, D. Graham and Manitoba Hydro Forces.

MR. HOLLINGWORTH: I wonder if I could stop you for a moment and maybe you could tell us what a cat swing contract is.

A Well it's a terminology that was applied in Manitoba to the type of operations that were carried on by Sigfudson Transportation Company for a number of years, where the materials were moved using tractors. hauling sleigh covered and uncovered sleighs of material over ice and winter roads.

MR. HOLLINGWORTH: Thank you, sorry to interrupt.

A In 1967, with Gibb Underwood McLellan in Winnipeg, Project Leader, Churchill Diversion Contracts and Assistant Director of Hydraulics Division, I was engaged in mobilization, logistics and construction of access roads, camps and transfer facilities on the Churchill Diversion Project. I also during that period of time, made a submission to the Royal Commission on

Northern Transportation, on Winter Road Techniques and comparative economic analysis.

In 1968 I supervised contracts for hauling bulk materials from Lynn Lake, Manitoba to Wallaston Lake, Saskatchewan, at an exploration site, via winter roads on Reindeer Lake. The contractor in that case was Lyndal Transportation.

In 1973-74, With UNIES Limited in Winnipeg, I was engaged in relocation studies for part of the Hole River-Island Lake Road. This was a 270 mile road constructed each winter by Mi-Ki-Si Construction Limited. I also, during that period carried out analysis of winter roads for the Department of Northern Affairs, Manitoba, and winter airstrip construction for the same department. I also was engaged by the Department of Indian Affairs and Northern Development to investigate a winter haul road to Moose Lake Manitoba.

In 1975, with UNIES Limited, I was engaged most recently in a detailed analysis of the winter road network in Manitoba, airstrip and all-weather road construction and maintenance and haul costs. These studies were in relation to economic studies being carried out by the Manitoba Northlands Transportation Studies, Department of Regional Economic Development and the Province of Manitoba. I am currently engaged in studying transportation alternatives in Northern Manitoba for the Department of Industry and Commerce of that province.

Q Mr. Jarvis, have you

Q Mr. Jarvis have you provided technical advice to Foothills Pipe Lines Limited on the subject of winter road construction and maintenance?

A Yes, I have.

Q What is the nature and scope of that advice?

A It consists of the preparation of a report and schedules, indicating the probable durations of snow and ice road availability in various apreads throughout the pipeline route.

Q On what basis have these reports and schedules been prepared?

A They have been prepared on the basis of statistical evaluation of weather records in the regions with particular reference to snowfall accumulation and temperatures.

AVailable knowledge of the terrain to be tranversed, by the winter road, and personal knowledge of the various climatic criteria governing various phases of construction and maintenance of winter roads in similar terrain, with reference to results of research published in the literature.

Q Can you outline the results of those studies?

A Yes, the results of investigations to date can be summarized by three figures, the first of which is displayed on the screen.

MR. HOLLINGWORTH: If you want to come forward to explain that, Mr. Jarvis, there's a

microphone on the Commissioner's desk.

A I didn't select the colours for this, that's Foothills Drafting Department's so if they offend anybody, blame them.

This indicates the situation as I see it on spreads one and two. That's going from mile zero on, and the way these charts were developed was to examine the snowfall, temperature records based on what information is available in the valley, and then to make judgments on what type of work related to winter roads construction could be carried out, under various climatic criteria that can be used to govern when you start or finish operations. There is a preparatory stage in winter road construction, where on certain types of terrain, a minimal amount of work will assist in furthering construction, and this little thing up here indicates when it would be possible to undertake that, what the average time is, what the absolutely earliest date is and what the latest date may be. Then to advance the construction of the road, certain other criteria must be available and this little thing here indicates the average and other dates of that. Again to carry the sort of traffic that is indicated, certain other climatic criteria and a certain amount of time is required to put the road in condition and this indicates when the average date, at which hauling may begin, and others, when the -- earliest possible date, the earliest probable and so on. These are given by this legend over here. I needn't go into them. Similarly with the closure over

here, the same sort of evaluation has been made. These bar graphs across the bottom are simply projections of say the average condition projecting it down here, and projecting it down here, giving certain haul durations in the one or two spreads.

Ifyou go to the next slide.

MR. HOLLINGWORTH:

Q I wonder if you might explain what spreads one and two are for our benefit. Are they at the north end of the line of sight.

A Yes, that's right, they're at the north end. We're going from north to south and this is the spreads three, four and five, we can't really put these together, but as you might expect, the haul durations would decrease somewhat as you go south, and then there's another slide which indicates the situation on the most southerly spreads.

MR. HOLLINGWORTH: Might those three slides be entered as one exhibit, Mr. Commissioner.

THE COMMISSIONER: Yes.

(WINTER ROAD CONSTRUCTION SCHEDULE BY CLIMATIC CRITERIA. SPREADS 1 AND 2 MARKED AS EXHIBIT 258)

THE COMMISSIONER:
So if you are doing very well, you get about six months even at the north end where the construction season, winter construction season lasts longer?

A Yes sir, it looks like that.

MR. HOLLINGWORTH:

Q You're suggesting that the climatic conditions will allow the use of winter roads as indicated by the chart ?

A That's correct, yes.

Q And what criteria have you used in establishing these probabilities?

A Well I don't know what exactly I said in the prepared evidence, but I think that chart on these are the criteria that I used.

Q I see, and if we could just have a moment, Mr. Commissioner, there's another slide. You might read your responses into the record for the sake of completeness, Mr. Jarvis.

To question 8 first.

A Okay. Well, yes on the basis of the current knowledge of the terrain conditions that I have and the statistics of the climatic record, the odds in any given year for duration of use can be established within the limits indicated.

Q And then on the criteria you have used in establishing the probabilities?

A Yes, the figures displayed here indicates a range of criteria for various winter

road operations. These are based on practical experience, research results and data on road use in the area and on similar terrain. The most conservative values on the -- or combinations indicated on the left of the chart have been used in preparing the schedules that were presented.

Q Can you explain exactly what a degree day is for me?

A Well the degree day figure we use is 100 degree days below 32 degrees Fahrenheit, is the number of -- if you take 10 days, if there have been 10 days of temperature 10 degrees below 32 degrees Fahrenheit, put them together and it gives you a hundred degree days.

Q So it's a multiple of a number of degrees below 32 times the number of days involved?

A That's right.

Q I see. Are there any other comments you have on this slide, Mr. Jarvis?

A No more comments on this.

Q I am proceeding then with the written testimony. Will these roads sustain the indicated traffic volumes over the periods indicated without damage to the terrain?

A Yes, if properly constructed and maintained.

Q What constitutes a properly constructed winter road?

A One that has sufficient

depth and density of frozen soil or snow to support traffic. It can be either frozen soil or compacted snow or a combination of the two.

Q Will there be sufficient snow available within the proposed right-of-way to construct winter roads and working pads?

A Statistical evaluation indicates that there is a high probability of adequate snow being available to construct these facilities over a high proportion of the proposed right-of-way, and reference is this slide here, which indicates the record of snowfall accumulation at three of the major stations going from north to south in the valley.

Q Thank you, Mr. Jarvis. I don't know if you want to stay there or take your seat. It's up to you.

A That's it as far as the slides are concerned.

Q Might the last table entitled "Range of Climatic Criteria" be marked as an exhibit, sir, and then this slide that is on the screen before you marked as an exhibit?

(SNOWFALL ACCUMULATION BASED ON RECORDED WATER EQUIVALENTS MARKED AS EXHIBIT NUMBER 260)

(TABLE Y, RANGE OF CLIMATIC CRITERIA REQUIRED FOR WINTER ROADS OPERATIONS MARKED AS EXHIBIT NUMBER 259)

MR. HOLLINGWORTH:

Q Going on with the written testimony, Mr. Jarvis, will this always be the case?

A According to statistical records --

THE COMMISSIONER: Miss Hutchinson, we just had some documents were to be marked as exhibits --

MR. HOLLINGWORTH: She's been handed copies of them, sir.

A According to the statistical record and conservative criteria, yes. The possible exception being the first 10 to 20 miles of the line, although we consider the snowfall records at some stations in that area to be misleading. Those are in these more barren areas due to wind sweep at recording stations. In any event, snow can be harvested off the right-of-way in these areas quite readily without damage to the surrounding terrain.

THE COMMISSIONER: Now there you are talking about the line where it starts out on Richards Island?

A THat's right, yes.

MR. HOLLINGWORTH:

Q If unfavourable climatic conditions were encountered in a particular year, would the haul period then have to be restricted?

A Not entirely. It may be possible to extend the period of hauling at both ends using artificial snow making equipment. This equipment

will be available on the line for ice bridge construction and for maintenance of critical areas. The indications are that the minimum possible haul period could conceivably be extended to the average haul period using this equipment but it would be costly. This decision would have to be made by the applicant and is essentially one of economics which I have not analyzed.

Q You mention ice bridges. What are the proposals put forward in this regard?

A The applicant is proposing to construct bridging over designated crossings up to 200 feet in width, and in some cases wider. This procedure should avoid construction, maintenance and environmental damage problems which can be encountered at these crossings due to blockage of the stream channel. At longer crossings, approaches and ice bridges will probably be constructed using artificial snow making equipment producing slush. In my opinion, this should be preferable to more conventional flooding practices.

The applicant has expressed concern about possible blockage of major stream channels by built up ice at these crossings. My experience is that increased spring flow in major streams results in rapid deterioration of the underside of the ice wedge; however, if there is any indication that ice bridges could cause stream blockage, ripping of the road surface or approaches could and will be undertaken at the time of road closure.

Q Finally, a general question. Do you have any further comments prior to

cross-examination?

A Well I had indicated that I would submit any references and reports that I thought may be relevant at this point. I haven't referred to any reports in my testimonv and I have nothing to submit. Secondly, that we are continuing studies of winter road operations, and third, that much of the control and work relevant to winter road construction is one of judgment and experience in the field.

MR. HOLLINGWORTH: That completes the testimony in chief of this panel, Mr. Commissioner.

MR. GENEST: Mr. Commissioner, before the panel leaves, there are a couple of things. One of the reports, I think Mr. Marshall spoke to Mr. Hollingworth about this. One of the reports that is listed in support of the testimony of this panel is the Alyeska Pipeline technical specifications, which we do not have, and I wonder if we could get.

MR. HOLLINGWORTH: Well Mr. Marshall didn't speak to me about it. I understand that the pipeline specifications for the Alyeska line are some three feet in height, and --

THE COMMISSIONER: Are what?

MR. HOLLINGWORTH: A stack about three feet in height, and there's considerable difficulty getting those to you.

My understanding was, Mr. Genest, that you or your advisors did indeed have the technical specifications of the Alyeska pipeline.

MR. GENEST: It doesn't help me much to tell me what part Isure don't want to try and read them over the week/ end. Is there any way of getting this fined down as to what part of it you're running on.

A I think perhaps Mr. Bauer could help me out on that, question.

Q We don't have, Mr. Williams tells me , the tecnical specifications.

WITNESS BAUER:

A Referring to those tecnical specifications there were no codes made strictly as background material.

Q Well in what regard -- can I ask these questions?

THE COMMISSIONER: Go ahead.

MR. GENEST:

Q In what regard where they -- did you use them in coming to the conclusions you expressed in this testimony Mr. Bauer?

A It was primarily to comfirm, in other words, a proven method as Alyeska has adopted already to building and our planning.

MR. GENEST: Mr. Bauer, I'm sorry, I didn't get that?

A I say it was more or less to rely on a proven method as outlined in those design specifications.

Q As the methods of construction, was it sir?

A That's correct.

Q Sir, there's one more thing, if you would forgive me. Mr. Jarvis, I just didn't understand the meaning, if you take your spread charts, you have these little blocks on top of preparatory construction and haul and I just don't understand what that little block preparatory says which shows you're starting in October. What does that -- could you help me.?

WITNESS JARVIS:

A Yes, it indicates that going from the extreme left of that little block, that that given certain climatic criteria, certain conditions in the field, that that -- those climatic conditions would occur, that's the earliest possible date that you could expect to find those climatic conditions occurring. Going on down, and we've worked here on certain probabilities of occurrence. I call that the earliest possible date that certain criteria

Q That's the white block?

A That's right that's the beginning of the white block.

Q So that would be at the beginning of October, that's the earliest you can start the preparatory work?

A Yes, given certain criteria.

Q And what is that work. What do you mean by preparatory.

A Well I think you almost

have to specify the particular terrain that you were working in, in order to come to --

Q Can you just give me an idea?

A I can give you an idea that if you were working in a swampy area, wet area. muskegs that you would want to at first snowfall go in and begin compacting the snow with light load ground pressure vehicles in order to accumulate some frost, that's a standard practice.

Q What about terrain that is common to pipeline -- if there is such a thing?

A I think it's difficult to say that there is.

No, I think you'd almost have to specify the terrain, but that's one thing you would do.

Q Well what would it be at spread one?

A Spread one?

Q Yes, you've shown us a sheet on spread one and you've got a block of preparatory work in spread one. What is the --

A On spread one there would be very little in the way or preparatory work, unless it was putting in access to areas that you may want to remove snow from. You may go in there and prepare a road as best youcan in order to get in there quickly. It's the minimal amount of work that you can do to get -- to make things easier for you without damaging anything.

Q Now, I'm also told where the colours, I don't know if it's my misunderstanding, the green means minimum possible, at least the white means the earliest possible start?

A That's right, yes.

Q And is that orange?

A Yes.

Q That's average?

A Yes, that's early probable start, when you hit the orange that's the date on which the early probable date.

Q You know about the colours I can't make sense of the colours. As I read this, the minimum probable is later than the average. Now am I wrong?

THE COMMISSIONER: Don't look at me. I believe you're reading it the same way.

MR. GENEST:

Q Or should it be reversed?

A I think we got off to a good start there, that we started with the earliest possible date we go along, going from left to right, we hit the orange bar, that is the earliest probable date, that's about a 75 percent probability and then we --

Q You see the orange at the bottom is average.

A Yes, I see what you mean. Okay, yes.

Q I should reverse those colours should I?

A That's right, the colour coding there is a little confusing all right.

Q Okay. So on the top of the boxes for orange, I should read ochre or rust.

A Yes.

THE COMMISSIONER: What's the -- I probably don't understand. I understand those bars at the bottom, at least I think I do. That's the haul duration, we can all perceive that. And I can see why on those graphs or at those boxes on the left, the green is latest in time because that's the shortest period of haul, presumably that's the most southerly limit of this thing?

A Yes.

Q Well then why is the closure latest in time for the green which is the shortest haul. Is that supposed to be May, Closure in May or is that sitting out there with no relationship to the bar -- to the line coming through it.

A I think again, we tried to put a little bit too much on one chart here, but the green in the event, when you are in the closure period, the -- if you project the very last date in closure down, you end up with a maximum possible so that the green in that instance indicates the latest possible closure.

MR SCOTT: Isn't the trouble, Mr. Commissioner, that if you read the four little gobs

at the top, according to the description contained in the right hand margin, I understand that, then if you go to the bottom, the colours are all reversed.

MR. HOLLINGWORTH: You can't use the same colours. That's how I see it.

And the red and orange should be reversed,

MR. HOLLINGWORTH: Maybe that's why Mr. Jarvis disclaimed responsibility for the colours, I wondered why he did at the time.

MR. SCOTT: I take it that it makes sense if you refer not to the colours so much as to the description of them?

A It might even be more easily understood if there were no colours on it at all.

MR. SCOTT:

Q I take it, Mr. Jarvis, just so I'll understand it, that if there were no colours on it at all, the block at the bottom you read according to the description in the left hand margin?

A That's correct, yes.

Q And the four little blobs that are floating around in space --

A Yes.

Q -- you read according to the description in the right hand margin?

A That's correct.

MR. HOLLINGWORTH: Well I don't think they are floating in space. They bear some resemblance to where they are in the calendar.

A If you project them downward, you end up with the bars at the bottom.

MR. SCOTT:

Q There is another problem that the draughtsman made in doing this. Shouldn't -- if you look at the description at the right hand margin which says "early probable start, late probable start, early possible start, late possible start", shouldn't that read early possible, early probable, late probable, late possible?

THE COMMISSIONER: That confused me too, Mr. Jarvis.

A Yes.

MR. SCOTT:

Q All right, Mr. Jarvis.

It's Friday night and I'll see you Monday.

A Okay, thanks, I will think about it.

THE COMMISSIONER: Just before you leave, that should be early possible, early --

A That's right. Early possible, early probable.

THE COMMISSIONER: Early probable, late possible, -- no, late probable, late possible.

A Right.

MR. SCOTT: That's how I understand it now.

THE COMMISSIONER: Yes.

MR. SCOTT: There's nothing like a chart to simplify the evidence.

THE COMMISSIONER: Any other questions you wanted to ask?

MR. GENEST: That's all I wanted to ask, sir.

THE COMMISSIONER:

Well we will adjourn. I should, Mr. Hollingworth, express through you my thanks to Mr. Gibbs and you and your witnesses for being willing to sit so late this week so that we could try to stay on schedule, and next week we'll sit at 1 o'clock and we will sit Monday evening as well, and we will try not to have any evening sittings for the remainder of the week. But it is conceivable that we

might have to, because I would like to finish phase 1 by the end of next week. I know it puts a strain on counsel and on the witnesses and on the staffs, but you will all thank me for it later on, so we will adjourn until 1 o'clock Monday.

MR. SCOTT: Mr. Commissioner, I would like to announce just before we go that the representative of the Department of Indian Affairs and Northern Development, Mr. Gamble, won the Ontario election poll, and I've got $20.00 for him.

Mr. Justice Berger came a very poor second.

(PROCEEDINGS ADJOURNED TO MONDAY, SEPTEMBER 22ND, 1975 AT 1:00 P.M.)